THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XXII.—No. 544.

TRANSFORMERS *v.* ACCUMULATORS.

IN our issue of last week we published Mr. Crompton's paper on the above subject recently read before the Society of Telegraph-Engineers. This week we give a continuance of the discussion, there being still more to follow in a future issue.

The champions of transformers and accumulators respectively have had their war of words, and it might be considered strange if after all that has been said on the matter neither side had lost or gained a man. At times party feeling has played a not inconspicuous part in the discussion, and here and there a little gratuitous advertising has been slyly indulged in. Though sharp blows have passed between the combatants, we believe we are not far out in saying that the peculiarity of the battle lies in the fact that there are no victors and no vanquished. In short, the chief points alluded to in the discussion were well known before, and the adherents of both systems are found at the end precisely where they were at the beginning of the controversy. Let us consider a few of these points.

It has been known for years that secondary batteries can be employed as transformers and arranged in groups to be charged in series while discharging in parallel. What was wanting to make this system of distribution a success was a reliable battery, and that Mr. Crompton claims to have found. We have in this journal reiterated the advantages possessed by a system of distribution which admits of storage, because we think that where storage is possible there is less risk of a breakdown. We have not shut our eyes to the fact that there are installations at work and huge installations too—witness the Edison system of New York—which have been an unqualified success from the beginning and which have worked for years without a single stoppage. We have admitted that by high-class management and well-directed arrangement a breakdown without storage is rendered highly improbable. But what then? Given the alternating transformer and the battery transformer if it can be shown that the erection and maintenance costs of the two systems which they represent are within reasonable distance the latter will generally be preferred for the simple reason that if both are efficient as transformers, the advantage of storage is enough to turn the balance. Supposing the B.T. system to cost rather more than the other, we believe other things being equal that engineers would not hesitate to adopt it for the sake of the immunity from breakdowns which it would give.

But it is not for the engineer to take sides for a system. His mind should be unbiased, nor would he select any particular system and declare it to be the best under all circumstances. In some cases transformers may suit better than secondary batteries, in others the reverse may hold good. Whether under careful management he is content to take the risk with the alternating transformer he must himself decide. Waiving the question of reliability let us look at some other points raised.

There are in the A.T. camp itself rival methods of distribution. The first is feeding by a network at a potential of 2,000 volts transformers situated one in each house, or one to two houses. The second is a distributing network supplying the lamps at 100 volts, the network being supplied from several centres or sub-stations, in each of which is fixed a large transformer. In the one case we have a complicated system of conductors at a high potential, in the other case a similar ramification at a low potential. In the latter case the conductors at high potential are restricted to the feeders leading from the generating station to the transformers at the sub-stations. Which of those systems will be adopted? for upon the decision depends in no small degree the first cost of the plant. When the lights are sparsely distributed, thus allowing overhead mains to be employed, everything behaves pretty well as far as insulation is concerned, but the lighting of every two houses out of three—if we must contemplate such remote contingencies—means putting the wires underground, and here insulation difficulties are liable to be met with. We know of no underground conductors carrying a current of 2,500 volts in this country at the present time, and we think he would be a bold, not to say reckless, individual who would advise laying down a complicated house-to-house network of conductors at this pressure. Again, in making comparisons, it is not to be forgotten that a mean alternating difference of potentials of 2,500 volts may mean a maximum difference ranging from 4,000 to 6,000 volts, according to the design and construction of the machine.

It appears, then, that safety compels us to adopt the plan of distributing at a potential of 100 volts from several sub-stations. The plan is already working on the Continent, and it is the plan which Mr. Kapp, the leader for the moment of the transformer party, is prepared to adopt. If there are as many transformers as there are groups of batteries, the distributing mains will cost the same in both the A.T. and B.T. systems, so that here we equalise an important item. We presume Mr. Crompton objects to a higher difference of potentials than 500 volts in underground mains charging accumulators. This is a wise precaution, as due to part of the circuit consisting of fluid conductors, a higher difference of potentials would introduce an element of danger. For the charging mains of the two systems we have therefore to compare the cost of cables to carry the currents required by potentials of 2,000 volts and 500 volts respectively. If the B.T. distribution requires more than four centres, the additional centres must be obtained by adding on fresh parallels. For 12 centres, for example, there would be three parallels from the generating station having four groups of batteries in series on each. It is far from

easy to give straight off the relative costs of the two charging mains, but we should probably be near the mark if we said that the B.T. mains would cost not less than five times as much as the others if the waste in both were the same. We have here, then, a rather large item to be charged against the B.T. system.

Coming to the generating and transforming plant, we have reasons for believing that Mr. Crompton's estimate for transformers is rather high, but if on the other hand we remember that his estimate for alternating current dynamos and exciters is about £2,000 too low, his total for dynamos and transformers may not be far out. Accumulators doubtless cost more than transformers, but seeing that for the A.T. system a greater amount of engine and boiler power is required, we think from a fair consideration of the subject that the additional cost of engines, boilers and dynamos on the A.T. side will balance the cost of accumulators over transformers on the B.T. side. Thus we have, as regards first cost, everything pretty much equal for both systems, save that the item of charging mains is considerably greater on the B.T. side. We have every desire to be perfectly fair in our remarks, and trust that exponents of both systems will not hesitate to criticise our figures should they consider them open to objection.

We cannot say much on the subject of maintenance, because the data at our disposal obtained from stations already working are far too vague to render a comparison possible. As regards attendance at the charging stations and sub-stations, it is possible that on the whole the cost will be nearly equal for A.T. and B.T. systems, for although the A.T. dynamos have to run longer hours, the transformers at the sub-stations can be safely left to themselves with a brief daily inspection, accumulators, on the other hand, requiring a considerable amount of attention to keep them in proper working trim. The argument for the increase in the coal bill due to working longer hours with alternating transformers breaks down when we remember that the machines may be belted, or directly driven from separate engines, the number of which may be increased with the load. Lastly as to efficiency, we think there is not much difference between the two systems. It is certain that accumulators have never been made to give an efficiency of 70 per cent. in practice, and it is questionable whether transformers partially loaded will give more. At any rate, until we have absolute working results of both systems before us we do not see how we can arrive at a more satisfactory conclusion.

It is to be regretted that Mr. Crompton did not confine his attention simply to the facts and figures obtained at Vienna without estimating for a hypothetical installation much larger. What is the actual efficiency obtained in that installation? What is the actual expenditure and what the receipts? On these points we have at the moment no evidence, nor have we evidence of a similar character on the A.T. side. The opinions expressed must consequently be of a somewhat speculative character, and are in many cases, we fear, influenced by the personal factor. As far as we can judge with our present information, the reliability secured by the use of accumulators is purchased simply at the cost of larger charging mains.

REFERRING to the exhaustive tests made by Dr. von Waltenhofen on the Reckenzaun storage battery, we may state from our own knowledge that it was also submitted to the Electrotechnical Institute in Vienna, not so much for its small weight as compared with storage capacity, but more for its superior construction and greater durability. This battery was sent to Vienna 12 months ago, and it had been in continuous use in London for 18 months previous to this transfer. The battery, therefore, is now two years and a-half old, but we have no information as to its total period of use in Vienna up to this date. The results obtained by Dr. von Waltenhofen and his confrères appear to be highly satisfactory. At the normal current rate the discharge exceeded a capacity of 212 ampère hours; whereas at the *very high* rate of 57·6 ampères, no less than 188·64 ampère hours, or 353·42 watt hours, with a fall of potential of 8·16 per cent. were obtained. Those who have had any experience with storage batteries will appreciate Mr. Reckenzaun's courage in submitting for test the oldest battery he had in his possession at that time to the independent scrutiny of some of the highest scientific authorities on the Continent, and we know that Mr. Reckenzaun's persistent endeavour for many years has been to produce a durable accumulator, for in his mind, as in ours, the question of *durability* is of the very first importance. Whatever the Patent Office record may show, we say, emphatically, that the man who has produced a *durable* storage battery, especially for the uses of electric locomotion, deserves all the credit the world can bestow upon him. Mr. Reckenzaun has worked hard and conscientiously in this direction for many years, and we tender him our congratulations at the success he has so far obtained. The tests show that for a kilogramme of plates the mean discharges of the Reckenzaun, Julien, and Farbaky-Schenek storage batteries are respectively 2·4, 2·6 and 2·9 ampères with average falls of potential of about 8 per cent. These figures look particularly well for the two latter types of cell, but of what use are they if, as in the case of Julien, the depreciation on the batteries employed in the Brussels cars is estimated at 3½d. per car mile? The gain in lightness of plates is far more than counterbalanced by their want of durability.

A MR. POTTAGE, of Edinburgh, who lays claim to the distinction of being an homœopathic chemist, is the latest, if not the greatest, benefactor to suffering humanity, yet brought before our notice. He dispenses to his fellow beings vegetable electricities coloured red, yellow, white, blue, and green, the latter pigment being doubtless found in profusion in the "eye" of those who patronise this enterprising gentleman, who acts as agent for the inventor, Count Mattei. These vegetable electricities are supplied in *original* bottles "at a price within the reach of all," and the five colours appear to be sufficient to cover all the ills to which flesh is heir. It is almost a pity that the ingenious Count did not further develop his discoveries to the extent of rivalling the rainbow, for we could then have been supplied with a tinted elixir for each of the seven ages of man. These wonderful additions to known medical remedies pale, however, before the "electric sulphur egg" which, we understand, is the outcome of Mr. Pottage's own brain, possibly from an excess of phosphorous caused

by over indulgence in Scotch haddocks. Rheumatism, sciatica, cramps, sleeplessness, pains in the limbs and joints, rapidly succumb to the potent and mysterious influences of the "egg" which has only to be grasped by the hand. We now feel more than ever the hopelessness of preaching a crusade against electropathic belts, galvano-magnetic batteries, magnetic chest protectors, and the host of bogus appliances which are continually being foisted upon an unsuspecting public, for if panaceas like those we have just enumerated command a sale, nothing we can say or do will create any suspicion that extensively advertised things are not always what they seem. The only way in which such illicit trading can be reduced to a minimum is by a vigorous onslaught from the whole of the medical press whose comments would probably find their way sooner or later into the daily newspapers, with the ultimate and beneficial result of Parliamentary interference; or a lesson might be learnt from Holland where, we believe, it is punishable by law to purvey the majority of quack medicines.

WE beg to thank a number of correspondents for supplying us with cards of admission to a "Vocal Concert and Electrical Entertainment" given in an Oxford Street establishment. As one of our friends pathetically remarks, "it appears sad that so charming a combination should be missed," but alas! our duties compel us to forego the pleasure of being seen amongst an audience which will doubtless be representative of the artistic, scientific, literary and musical talent of the Metropolis. We felt tempted to add wisdom, but that we are sorely afraid will be found embodied only in one solitary individual, the promoter of these variety shows. One point on the card worthy of notice is the notification "children not admitted," but are not the patrons of the celebrated emporium at the corner of Rathbone Place already in their second childhood?

PROFESSOR ANDREW JAMIESON, of Glasgow, has recently made an elaborate report upon the "Griffin" patent double-acting horizontal gas engine. From the published results we can only draw one conclusion, which is that the engine, if not the very best, has no superior in the market. For driving dynamos Mr. Jamieson thinks it admirably adapted, from its greater steadiness, and the absolute and practical efficiencies or ratios of indicated horse-power and of brake horse-power to gas consumption in terms of heat units are higher than he has hitherto obtained from any gas engine. The report was made for Messrs. Dick, Kerr and Co., 101, Leadenhall Street, who would doubtless supply our readers with further information upon request.

THERE may be some reason for the outcry in large towns against the multiplication of overhead wires; the number spanning nearly every important thoroughfare is so vast that it is not difficult to understand why a timorous public should become impressed with the belief that they constitute a possible danger. But in comparatively small towns, where there is but a very remote possibility of the network becoming extensive, it is provoking to find men on local boards and town councils who stand in the way of the adoption by their more progressive fellows of such an important aid to business as the telephone, by objecting to the erection of overhead wires. Yet there are many such, and Southampton affords a recent example. Fortunately here the more sensible members were in the majority, and permission to run a certain line was given to the Western Counties Telephone Company. One councillor urged as a reason why they should accord the company every facility, that they might possibly find themselves in the position of the people at Cheltenham, who in the first place refused permission for the carrying of the wires overhead and afterwards petitioned the company to come again and give them the telephone.

A FINANCIAL paper has just heard of the recently proposed project of experimenting with electrical propulsion on the Underground Railway, and visions of an early reduction of 50 per cent. in working expenses are being conjured up as the result of the announcement that the company is "negotiating an arrangement." There have been negotiations; there is that amount of truth in the rumour, and we mentioned the fact some months ago. Unfortunately, perhaps, nothing more than negotiation has yet taken place, and for the present even this, we believe, has ceased, so that the long-suffering public must postpone its anticipated enjoyment of a purer atmosphere beneath the London streets, and the equally enduring shareholders of the Metropolitan District Railway Company the realisation of their hopes that electricity will step in and increase their dividends.

ON Monday, the 23rd inst., a most successful dinner was given in honour of Sir John Pender, K.C.M.G., by the directors and staff of the Eastern and allied telegraph companies, and by some personal friends. The meeting was an agreeable one, as a goodly company of distinguished men were brought together by the magic word "telegraph." It is regrettable that at an ostensibly telegraphic dinner, among some 200 present, there were only Mr. Latimer Clark, and perhaps one or two other less known men, to represent those who manfully and successfully struggled with the technical difficulties of submarine telegraphy in its early days. It is true that death has thinned the ranks, but of those left no Thomson, Bright, Canning, de Sauty, Brett, or Willoughby Smith was there. Perhaps we do wrong to regret their absence, as a purely personal feast of this kind can hardly be expected to take a prominent position in the annals of telegraphy. A Lord Mayor's banquet does not greatly affect the history of the City of London; it is simply one feast, and nothing more. The chairman coupled the name of the guest with submarine telegraphy, and no one can seriously cavil at his doing so, as Sir John Pender's shrewd, energetic character, and more than average ability, have played their part in the development of submarine telegraphy, aided as they have been by a knowledge of men which has secured him willing tools to do his bidding. Exception might be taken to the details of some of the speeches delivered, which were apt to attribute to Sir John Pender a position he cannot fairly assume. Among the city men he has been a success. He made his venture, and has won the stake. What he has done for telegraphy could have been done by others almost equally, if not quite so well. With the Thomsons and others the case is different; but for them, and such men are very scarce indeed, a century might easily have elapsed while submarine telegraphy remained a conquest for future generations. As a successful business man, let Sir John Pender have his dinner in peace with such friends and their friends as circumstances may draw together; but these friends should neither be misled, nor should they misunderstand the true position of things telegraphic. *Palmam qui meruit ferat.*

NAVIGATION PROJECTOR.

WE illustrate below a navigation projector constructed by Messrs. Paterson & Cooper to the designs of Messrs. William Denny & Bros., the well-known ship builders of Dumbarton. The projector shown in fig. 1 is employed to light the course of vessels in shallow or dangerous waters, and the several sets of apparatus already supplied, consisting of projectors and dynamos, have given, in working, entire satisfaction. The projector consists of a silvered and polished elliptical reflector enclosed in an iron casing, the latter having a gun metal framed glass front opening on hinges, and a sliding door at the back for the renewal of the carbons. The reason for adopting the elliptical form of mirror was that by its use a diverging beam of any angle could be obtained which would utilise all rays, both direct and reflected. In practice, this result has been secured, and the beam, when projected on any plain surface, has been found to give an illumination practically uniform. The iron casing is mounted on a cast iron pedestal on which it is free to turn, the inclination being adjusted by a right and left hand screw, which is actuated by a hand wheel, as shown. The arc lamp, the works of which are enclosed in the turret, is a focussing Phœnix lamp with automatic adjustment, giving 12,000 candle-power and requiring a current of 60 ampères at a difference of potentials of 50 volts. Generally the dynamo has to furnish current for several incandescence lamps as well as for the projector, in which case the difference of potentials at its terminals is 65 volts, the incandescence lamps taking 60 volts and a resistance being included in the projector circuit absorbing about 15 volts.

Fig. 2 shows the dynamo supplied for a set in which, in addition to the projector, there was supplied current for 50 incandescence lamps taking 1 ampère each. It is compound wound and gives, at 825 revolutions per minute, a current of 110 ampères at a difference of potentials of 65 volts.

FIG. 1.

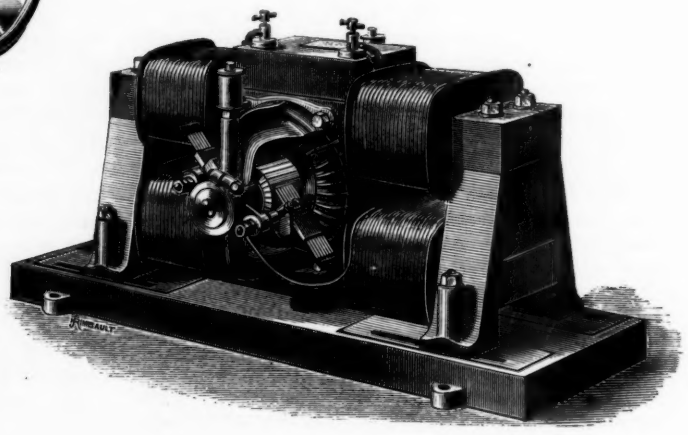


FIG. 2.

ELECTROLYSIS OF LEAD SALTS.

By ALEXANDER WATT.

(*Concluded from page* 357.)

26. *Oxalate of Lead.*—A bath was prepared by adding a strong solution of oxalic acid in excess to another of nitrate of lead; the mixture was then heated, when a considerable proportion of the precipitate at first formed became dissolved. The vessel was then set aside to cool, when the clear liquor was poured off and afterwards electrolysed with a single Daniell cell. It was noticed, however, before the circuit was completed by the immersion of the negative electrode that the lead anode became coated with a dense white deposit (probably a basic salt) which fell from the plate and settled at the bottom of the vessel. When a copper cathode was immersed in the liquid it at once received a bright film of lead, while no gas was given off at its surface. An attempt was next made to form an electrolyte by digesting moist carbonate of lead in a hot solution of oxalic acid, the mixture being afterwards boiled for a few minutes, and then set aside until cold. The resulting clear liquor was electrolysed with the current from three Daniells, but a very slight film of lead only was received upon the cathode. The lead anode, as in the former case, decomposed the solution, and became thickly coated with a white deposit, which, as before, fell off the plate in dense flakes.

27. *Oxalate of Lead by Electrolysis.*—A strong solution of oxalic acid was first prepared, and in this was placed a lead anode and copper cathode, the current being obtained from three Daniell's cells. There was moderate evolution of hydrogen at the negative electrode, and in about two hours a slight film of lead gradually formed upon its surface. After 12 hours' immersion a moderately thick film of the metal had been deposited, but there was no tendency to sponginess. The anode, which had been slowly acted upon, presented a fairly clean surface.

28. *Lactate of Lead.*—A solution of this salt was prepared by adding recently-precipitated and moist carbonate of lead to lactic acid, in the cold, in which it became freely dissolved, with evolution of carbonic acid, forming a clear solution, which was afterwards diluted with about four times its bulk of water. The bath thus prepared was electrolysed with the current

from a single Daniell, when a very prompt and bright deposit of lead was received upon a brass cathode. The liquid was next further diluted with water, after which the deposition became more gradual; in a quarter of an hour or so, however, the film assumed a dull grey appearance, with a slight tendency to sponginess, and in half an hour crystals of lead appeared at the lower edge of the plate. The film of lead obtained from this bath appeared on one side of the cathode only. There was no evolution of gas at either electrode, and the anode remained perfectly clean and bright, as though having been freely acted upon during the electrolysis.

29. *Ferrocyanide of Lead in Caustic Potassa.*—A quantity of ferrocyanide of lead was first prepared by adding a solution of ferrocyanide of potassium to another of nitrate of lead, and the resulting precipitate was afterwards well washed and drained. A moderately strong solution of caustic potash was next prepared, to which the ferrocyanide was gradually added until the potash solution was nearly saturated; the solution thus obtained was afterwards diluted with water and allowed to settle. The clear liquor was then poured off and electrolysed with the current from a single Daniell, when on immersing a brass plate this became promptly coated with lead—on one side only—the film being very bright at first, but afterwards turning dull. On examining the lead anode it was found to be coated with a brown layer of peroxide. The solution was next further diluted with water, when a freshly-prepared plate became more slowly coated, and the film retained its brightness for a longer period.

30. *Phosphate of Lead in Caustic Potassa.*—A bath was made from this combination as follows:—A quantity of chloride of lead was first prepared by adding a strong solution of common salt to one of nitrate of lead, the resulting precipitate being afterwards well washed with cold water. The precipitate was next dissolved in boiling water, and to this solution was added, cautiously, so as to avoid excess—as recommended by Mitscherlich, to prevent the formation of a sub-phosphate—a hot solution of phosphate of soda. The white precipitate of phosphate of lead thus formed was next washed several times with cold water, and a strong solution of potash then gradually introduced until the phosphate was entirely dissolved. The concentrated solution was next diluted with about eight volumes of water, and electrolysed with the current from one Daniell cell. On immersing a freshly prepared brass plate, this at once became coated with a bright film of lead; but after a few seconds the deposit assumed a dull appearance. There was vigorous evolution of hydrogen at the negative plate, and it was deemed necessary to dilute the solution considerably. When this was done, the subsequent deposit retained its brightness for a long time, while the anode exhibited a perfectly clean surface. It was noticed that the metal deposited from this bath adhered very firmly to the cathode, and there was very little disposition to sponginess, a very common characteristic of electrolytic lead.

31. *Benzoate of Lead.*—To form a bath from this compound a boiling hot solution of benzoic acid was first prepared, to which was added, in small quantities at a time, moist carbonate of lead. On each addition of the carbonate there was moderate effervescence, and when this subsided a further addition was made; the mixture was then boiled for a few minutes, and afterwards set aside until cold. The clear liquor was electrolysed with the current from three Daniells in series, when a very prompt film of lead was obtained upon both sides of a brass plate. The deposit, however, turned dull after a few minutes from the formation of spongy metal.

Peroxide of Lead Colourations.—In electrolysing the various salts of lead to which I have called attention in this series of papers I have frequently repeated results obtained with a lead anode by substituting one of platinum, or steel, or a polished nickel-plated surface, with a view to ascertain the colour, or variations of colour, the peroxide of lead might assume when formed upon the positive electrode under certain conditions. The details of a few of these results may not, it is hoped be uninteresting. In electrolysing a solution of the basic nitrite of lead with a platinum anode (3 Daniell cells being used) a yellow deposit of peroxide was first formed upon its surface, which was quickly followed by superb iridescence on both sides of the plate. After about one minute two rainbow bands appeared on the upper part of the anode, the remaining surface assuming a deep crimson colour, which gradually changed to a purple tone. The film of peroxide was very adherent to the platinum surface. With the solution of sulphate of lead in caustic potash, platinum and steel anodes received a golden yellow film, which, even after a long immersion, did not undergo any other change of colour. In a solution of lactate of lead a platinum anode at first became coated with a golden yellow film; this was succeeded by a steel grey at the lower portion of the plate; in a few seconds a deep orange colour began to appear at the lower corners, followed by the primary colours in succession, which rapidly blended, as in a prism, producing a remarkably fine effect, which could be readily modified at will by increasing or diminishing the surface of the cathode. In a solution of sulphocyanide of lead a platinum anode received a rich golden yellow film, but even after a long immersion no further colouration took place. In a solution of pyrophosphate of lead a golden yellow film only was obtained upon a platinum anode. In a moderately strong solution of nitrate of lead a very brilliant iridescent film was produced instantaneously; when this solution was considerably diluted with water, and a small cathode surface only immersed, the effects were still more striking, though developing more gradually. A solution of salicylate of lead yielded a rich golden yellow film, but no further colouration. In a solution of benzoate of lead a pale yellow colour was at first obtained, but this was soon succeeded by orange, then deep orange, with a slight tendency to iridescence. When the film was rubbed, while still moist, the prismatic colours at once became visible.

Crystalline Deposits of Lead.—When electrolysing the various salts of lead which have formed the subject of these papers, I frequently met with crystalline deposits of great beauty, which I was desirous of preserving if practicable. I had found that electro-deposited crystals of metals could be most satisfactorily obtained upon plane surfaces, and that when formed upon a transparent material, such as glass, for example, that impressions of them could be obtained by the ordinary process of photographic printing. In producing lead crystals upon flat surfaces with a view to preserve them, or to obtain photographic prints from them, there are certain details of manipulation which must not be neglected if we desire to obtain the best possible results. I will therefore briefly describe the method I found most successful after having experienced numerous failures. Suppose we desire to obtain a satisfactory group of crystals from a solution of the acetate of lead, either for preservation as an electrolytic specimen, or to obtain photographic prints from, we proceed as follows:—A plate of glass is first obtained. Ordinary photographic glass will be found most convenient, and easily procurable, and may be of the dimensions known as *quarter-plate*, *half-plate*, or "cabinet" size. The plate is to be laid in a flat dish, and a lead anode (say 2 × 3 inches) connected to the positive electrode of a small voltaic battery, is allowed either to rest on one end of the plate or in the dish, the former position being preferable. A thin strip of brass or copper may form the cathode, and this, suspended from the negative electrode of the battery, should be placed *on the glass* at the opposite end, as will be readily understood. A moderately strong solution of acetate of lead, slightly acidified with acetic acid, and filtered, is then to be poured into the dish until the glass plate has become completely immersed. In a few moments crystals of lead will form upon the cathode, and extend forward (and, indeed, backward also to a slight extent), and gradually spread over the surface of the plate until the anode is nearly reached, when this latter electrode may be removed. The brass cathode should now be

firmly and steadily held between the fingers, and the crystals attached to it gently removed with the blade of a penknife, care being taken not to shift the position of the main group of crystals. When the cathode is removed the glass plate should be gently raised at one end, which may be conveniently done by the finger and thumb of each hand, and the liquid allowed to flow from its surface *very* gradually, otherwise the crystalline film will slip off the plate; with ordinary care, however, this need never occur. The plate bearing the crystals may then be laid on blotting paper, supported at one end by a piece of wood, so as to allow the liquid to drain from the crystals freely. The fingers of the operator must be well rinsed after dipping in this solution. The solution is then to be poured out of the dish and the vessel well rinsed, after which the glass plate is to be again laid in the dish, and water very gradually and slowly poured in until the crystals are well covered, the object being to wash away all the lead salt that surrounds the crystals; much care is needed, however, to prevent them from shifting. Again, since water produces a white precipitate in weak solutions of the acetate of lead (unless very acid), it is necessary to remove the plate of crystals before the precipitate has time to settle. The glass plate, therefore, should be removed, as before, almost immediately after the water has covered the plate, and the liquid then thrown away and the washing process resumed, the operation being repeated several times to remove every trace of the lead salt. If this is not effectually done any acetate that may remain in contact with the crystals will react upon them in the process of drying, causing them to become dull and brittle: when well washed they should appear perfectly bright and metallic. The plate, after being allowed to drain well upon a pad of blotting paper, may next be held near a fire until the crystals are perfectly dry. As soon as the plate has cooled so as to feel merely warm when touched with the back of the hand, a thin chloroform varnish—such as is used by photographers—may be poured on the plate at one corner and allowed to flow all over, the surplus being conducted to the varnish bottle by tilting the plate. The plate should then be very gently warmed to prevent the "chilling" of the varnish.

To obtain a photographic print from the crystals, the plate must be treated in all respects in the same way as an ordinary photographic "negative." The plate being laid in a pressure-frame, crystals upward, a piece of albumenised paper, sensitised in the usual way, is laid upon it, and above this several folds of blotting paper; the jointed back of the frame is then laid over all, and the springs adjusted as usual. To obtain a perfect impression of the crystals the glass of the frame should be exposed to strong sunlight for at least half an hour, and it is probable that even double that time may be necessary to secure all the finer details of some of the more fibrous crystals. When the printing is complete the photographic print is removed and fixed and toned in a solution of hyposulphite of soda, to which a small quantity of chloride of gold has been added, in the usual way, and it is afterwards well washed and dried, when it may be trimmed and mounted on a suitable card. The accompanying engravings are reproductions of three photographs which I lately obtained in the manner indicated. Fig. 1 is from a photo of crystals produced with nitrate of lead, and figs. 2 and 3 respectively represent those produced from the acetate of lead. As there are some points connected with the crystals obtained from the first-named lead salt which need special attention, I will briefly state the method by which, after many failures, I succeeded in obtaining fairly good results. To produce crystals of lead from the nitrate I found it best to employ a rather weak solution, using the current from 3 small Daniells, arranged in series. My object being to obtain a group of crystals lying as flat as possible on the glass plate, I soon found that the nitrate of lead solution was less favourable than the acetate in this respect, for some of the crystals persistently grew *upward*, the entire group much resembling the naked branches of a tree in winter time. Many attempts were made to overcome this peculiar growth, amongst which I tried the following with a view to compel the spiky branches of the crystals to grow *laterally*: Having laid the electrodes flat upon a glass plate—one at each end, as before—a second plate was laid over all, and the solution of nitrate of lead then poured into the dish until it

FIG. 1.

covered both plates, and at the same time filled the space between them. I found, however, that the resistance offered by the thin layer of liquid was so great that no deposit of the metal took place beyond the immediate vicinity of the cathode even after many hours. The plan was, therefore, for the time abandoned, and the crystals represented in fig. 1 obtained with the single plate as before described. To obtain a photographic

FIG 2. FIG. 3.

print of the crystals it was found necessary, after the plate had been varnished, to gently bend the more upright crystals downward a little, so that when submitted to the pressure of the printing frame they would lie as flat as possible without breaking away from the remainder of the group.

In conclusion, I may remark that when it is desired to modify the forms of lead crystals, obtained from either of the salts named, this may readily be effected by increasing or diminishing the strength of the solution, and also by modifying the current density, some exceedingly beautiful results being obtained with very weak currents—say, a single small Daniell cell—and

employing a rather dilute solution of nitrate or acetate of lead. Under these conditions some very fine specimens of electrolytic crystals may be obtained in two or three hours upon a glass plate 6 or 8 inches in length.

THE VOLT, THE OHM AND THE AMPERE.*

By FRANCIS E. NIPHER.

THERE are many engineers who do not understand the nature of the investigations which have led to the adoption of the familiar units named above, and who do not find in works accessible to them a sufficiently clear discussion to enable them to understand, for instance, how the electrical resistance of a piece of wire like the one which I hold in my hand can be 6,200 miles per second.

The experiments upon which the determination of these units was based were made with exactness by the committee of the British Association.* The equations for the reduction of the observations were written by Prof. Maxwell. These equations take into account many corrections that must be made, and do not well serve to bring out their full meaning to one not conversant with the subject.

A simpler form of apparatus, such as the one represented in diagram in fig. 1, although impracticable for experimental determinations, will serve a much better purpose for an exposition of the subject.

Let Z N N′ S be a circular closed wire, revolving around a vertical axis, Z N′, in a field of magnetic force of strength, H. The value, H, is determined in units which depend only on the centimetre the gramme and the second, by means of a magnetometer. The strength of the field is also called the number of lines of force per square centimetre, and in fig. 1 the lines are supposed to be parallel to the line, N S. On the plane, Z W N′ E, the number of lines to the square centimetre will be everywhere the same, and equal to H.

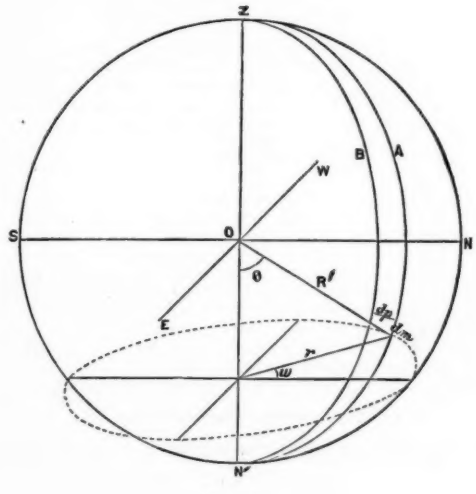


FIG. 1.

At any instant let the plane of the coil be represented by Z A N′, making an angle, w, with the meridian plane. During an interval, $d\,t$, the plane of the coil, will sweep through an angle, $d\,w$, the new position being Z B N′.

The area of an element of the surface of the generated sphere will be

$$d\,s = d\,p\,.\,d\,m$$

where $d\,m$ is an element of one of the meridian circles and $d\,p$ is the arc of the horizontal parallel at the same point, subtending the angle, $d\,w$.

Let θ = angle between the vertical radius, O N′, and the radius drawn to the element, $d\,s$, R′ being this radius and r the radius of a horizontal parallel cutting, $d\,s$.

Then

$$d\,p = r\,d\,w = \text{R}'\sin\theta\,d\,w$$

$$d\,m = \text{R}'\,d\,\theta$$

$$d\,s = d\,m\,d\,p = \text{R}'^2\sin\theta\,d\,\theta\,d\,w$$

Let $d\,s'$, $d\,m'$ and $d\,p'$ be the projections of $d\,s$, $d\,m$, and $d\,p$ on the plane, Z W N′ E.

$$d\,p' = d\,p\cos w$$

$$d\,m' = d\,m\sin\theta$$

$$d\,s' = d\,p'\,d\,m' = d\,p\,d\,m\sin\theta\cos w$$

$$= \text{R}'^2\sin^2\theta\,d\,\theta\cos w\,d\,w$$

Keeping w constant, if we integrate the last expression between the limits 0° and 360°, we shall get the area of the projection of the spherical sector intercepted between the two planes, upon the plane, Z W N′ E.

$$\int_0^{2\pi}\sin^2\theta\,d\,\theta = \left[\tfrac{1}{2}\,\theta - \tfrac{1}{4}\sin 2\,\theta\right]_0^{2\pi} = \pi$$

Calling this sector projection s′

$$s' = \pi\,\text{R}'^2\cos w\,d\,w.$$

The electromotive force of the wire being the number of lines of force cut per second, we have

$$\text{E} = \frac{8\,\text{H}}{d\,t} = \pi\,\text{R}'^2\,\text{H}\,\frac{d\,w}{d\,t}\cos w$$

If A = π R′² and n = the number of revolutions per second, then the angular velocity $\frac{d\,w}{d\,t} = 2\,\pi\,n$.

Then the value of E is

$$\text{E} = 2\,\pi\,n\,\text{A H}.\cos w. \qquad (1)$$

The average cosine being $\frac{2}{\pi}$, the average electromotive force in

$$\text{E} = 4\,n\,\text{A H}. \qquad (2)$$

When the plane of the wire is at right angles to N S, the number of lines inclosed by the wire is A H. After a quarter revolution the number inclosed is 0. Hence A H lines are cut during each quarter revolution, and 4 n A H will represent the number of lines cut per second.

In (2) the area being in square centimetres, and H being measured also in C.G.S. units, it is evident that E is expressed in terms of the same units.

If now the coil were broken, say at N, and connected with commutator bars and brushes so that this electromotive force could be compared with that of a Daniell cell, it would be found that when the E.M.F. of the coil and cell balance, the value of E as calculated by (2) would be

$$\text{E} = 107{,}000{,}000.$$

This number is too large to be convenient, and so a practical unit 10^8 times as large is selected, and it is called a volt. In volts, then, the E.M.F. of a Daniell cell is 1·07.

It will be understood that the single coil could not be given a speed which would produce an E.M.F. of one volt. For the real determination a coil of many turns would be required.

By Ohm's law and equation (1) the current at any instant during the revolution is

$$\text{C} = \frac{\text{E}}{\text{R}} = \frac{2\,\pi\,n\,\text{A H}}{\text{R}}\cos w \qquad (3)$$

where R is the coil resistance.

A small magnet is suspended at the centre of the coil, upon a silk fibre which passes up through the hollow axis at Z. This magnet is deflected by the action of the coil, and comes to rest when the turning moment due to the earth's field balances that due to the coil.

The force of the field on one pole of the magnet is H m, where m is the strength of the pole. The component of this force resolved at right angles to the magnet is H m sin a, where a is the angle of the magnet axis with the magnetic meridian.

To find the force of the current upon the same pole, consider the effect of an element of a current having any form upon a

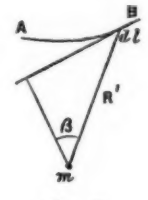


FIG. 2.

pole, m. In fig. 2 A B is the conductor carrying a current, C. The force of any element, $d\,l$, of this current upon the pole, m, is

$$d\,f = k\,\frac{\text{C}\,m\,d\,l}{\text{R}'^2}\cos\beta.$$

Where K is a constant, R′ is the distance between the element and the pole and β is the angle between the lines drawn from m to the element, and from m at right angles to the tangent of the conductor at the element.

To get the effect of a finite portion of the circuit this expression must be integrated along the wire between the limits assigned to l, which can be done whenever the geometry of the

* Read before the American Association of Engineering Societies, January 4th, 1888.

* Reports of Electrical Standards, p. 96.

circuit is known. In the case of the circular wire with the poles at the centre, $\cos\beta = 1$ for all parts of circuit, and the expression is therefore merely to be integrated in l. The force on one pole is therefore

$$f = \text{K}\frac{\text{C}\,m \times 2\pi\,\text{R}'}{\text{R}'^2}$$

If now C be made unity when the current is so adjusted that the action of a centimetre of wire, every part of which is a centimetre from a unit pole and which is traversed by this current, acts upon the pole with a force equal to one dyne, the constant, K, becomes unity. The value of C is hereafter therefore to be understood as expressed in the above chosen centimetre-gramme-second unit.

Replacing C by its value as previously determined (3)

$$f = \frac{4\pi^2\,\text{A}\,\text{H}\,n\,m}{\text{R}\,\text{R}'}\cos w.$$

This being the force at right angles to the coil, the component at right angles to the needle will be

$$f' = \frac{4\pi^2\,\text{A}\,\text{H}\,n\,m}{\text{R}\,\text{R}'}\cos w\cos(a - w).$$

This force will fluctuate during a revolution, being zero when w is 90° or 270°, when the coil is not cutting lines of force (the value of E in (1) becoming zero), and when $a - w = 90°$ or 270°, when the force of the coil is longitudinal with respect to the needle, the needle being at right angles to the coil. For intermediate positions, as is well known, the sign of the turning moment on the needle will remain unchanged, since the reversals of the current are simultaneous with reversals of position of the wire with respect to the magnet.

Moreover, when the experiment is made with a speed of ten revolutions per second, the needle appears perfectly steady under telescopic observation with a reflecting scale, the needle being in the form of a small sphere of steel.

It becomes necessary then to find the average value of the expression $\cos w\cos(a - w)$

$$= \cos a\,(\cos^2 w + \tan a\sin w\cos w),$$

where a may be considered constant. To do this the expression within the parenthesis must be multiplied by $d\,w$ and integrated between the limits of 0° and 90°, dividing the integral by the arc of 90°. Calling the average value of the parenthesis, S, it is

$$\text{S} = \left[\int_o^{\frac{\pi}{2}}\cos^2 w\,d\,w + \tan a\int_o^{\frac{\pi}{2}}\sin w\,\cos w\,d\,w\right]\frac{2}{\pi}$$

The values of these two integrals are well known, and are represented in figs. 3 and 4, which are obtained by laying off $\sin^2$, and cos × sin along the rectified arc between 0 and 180°.* The average value sought is simply the sum of the average sections of

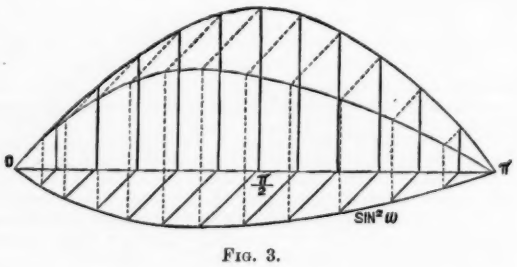


FIG. 3.

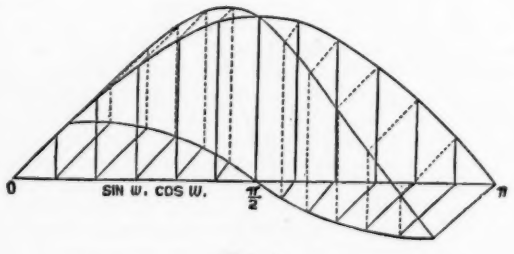


FIG. 4.

these two solids, the latter being multiplied by a constant tan a. Performing the integrations, and calling f'' the average value of f',

$$f'' = \frac{4\pi^2 m\,n\,\text{A}\,\text{H}}{\text{R}\,\text{R}'}\cos a\left(\tfrac{1}{4} + \frac{\text{tang}\,a}{\pi}\right).$$

For equilibrium of the needle this must equal $\text{H}\,m\sin a$. Hence remembering that $\text{A} = \pi\,\text{R}'^2$

$$\text{R} = 2\pi^2\,\text{R}'\,(2 + \pi\cot a).$$

The average distance of the elements of the wire from the axis of revolution is $\frac{2}{\pi}\text{R}'$. The average circumference described by these elements is therefore $4\,\text{R}'$. Hence the average velocity of the wire in space is $4\,n\,\text{R}' = v$.

Substituting this value in the above equation, we have finally

$$\text{R} = \frac{\pi^2}{2}\,(2 + \pi\cot a)\,v.$$

This value of R is therefore expressed in centimetres per second. If a wire having a resistance such as we call 1 ohm could be revolved in the manner here discussed, so as to produce a measurable deviation, the value of R would be found to be 1,000,000,000 centimetres per second. The numbers expressing resistances of such pieces of wire as are ordinarily used are thus seen to be very large numbers. For practical purposes a new unit 10^9 times as large as the C.G.S. unit is called the ohm.

Since by Ohm's law

$$\text{C} = \frac{\text{E}}{\text{R}}$$

it is evident that since both E and R have been determined in C.G.S. units, the same can be said of C. Since, furthermore, the practical unit E or volt is 10^8 C.G.S. units, and the ohm is 10^9, it is evident that the practical unit of current to be chosen in order to avoid the introduction of a constant into the last equation must be 10^{-1} C.G.S. unit. This practical unit is called the ampère. Ten ampères thus make a C.G.S. unit. These changes from C.G.S. units to practical units may be said to be brought about by the adoption of 10^9 centimetres, or an earth quadrant as a new (but not very practical) unit of length, and 10^{-11} gramme as the new unit of mass, the unit of time remaining the second.

This change is the practical solution of the difficulty, that measured in C.G.S. units, resistances and potentials (electromotive force) are represented by very large numbers, and quantities and capacities by very small fractions.

The labours of the British Association Committee with the revolving coil resulted in placing upon the market a standard ohm, which has taken the name of the B.A. ohm. Later investigations seem to indicate that the B.A. ohm is about 0·9864 of the true ohm—10^9 C.G.S. units—and that the best value for the ohm will be the resistance of a column of pure mercury at 0 degree C, whose section is one square millimetre and 106·278 centimetres in length.

The Paris Congress of 1884 adopted for ten years a column of mercury as above, and 106 cm. in length as a unit of resistance, and called it the *legal ohm*. It is expected that before 1894 the slight difference between the legal ohm and 109 C.G.S. units will be determined with sufficient precision for all ordinary purposes, and that the legal ohm will then receive the slight adjustment needed to make it agree with the theoretical value. The legal ohm is 1·0112 B.A. ohms. The *legal volt* is the electromotive force which will maintain a current of an ampère through a conductor whose resistanee is one legal ohm.

The *legal ampère* is thus 10^{-1} C.G.S. units of current.

ON SOME EARLY FORMS OF ELECTRIC FURNACES.*

By PROF. EDWIN J. HOUSTON.

JOHNSON'S ELECTRIC FURNACE.

THE idea of directly utilising the intense heat of the voltaic arc for the fusion of refractory substances, for metallurgical or other purposes, suggested itself at quite an early date to the minds of many inventors.

That such should have been the case is quite intelligible. When the earlier experimenters with the voltaic arc saw the most refractory substances melt readily in its very great heat, it is natural that they should think of applying it to such operations as required high temperature in a limited space.

In some of the early forms of electric furnaces, to which we have already referred, the heat of the arc was indirectly utilised.

That which we shall now describe employed this heat directly for the smelting of ores.

On the 22nd of March, 1853, John Henry Johnson, filed in the office of the Commissioner of Patents of Great Britain, a provisional specification for Letters-Patent for an invention entitled "Smelting iron and other ores." This application was numbered 700 of 1853. The completed specification for the same was never filed.

Johnson described a furnace in which metallic ores, particularly iron, are smelted in a furnace, the heat of which is of electric origin. The ore to be treated, previously ground, was mixed

* It will be seen that in case of the solid represented by $\int \sin w\cos w\,d\,w$, the edge of the solid diagonally opposite the axis of arc is a helix, which makes one turn for every 360° of change in w. The sine and cosine curves are, of course, projections of that helix on any planes at right angles to each other, the line of intersection of the two planes being parallel to the axis of the helix. Revolving either the helix or the two planes about the axis of the helix will, of course, change the phase of the projection curves.

* *Franklin Institute Journal.*

with charcoal and dropped between the poles of large electrodes across which a voltaic arc was established. The ore thus treated was separated into molten metal and slag by being received in a suitable vessel placed above the electric furnace proper, in which it was maintained in a fused state by any suitable heat. In this vessel the molten mass separated in layers of different densities, in the well known manner.

The inventor gives the following description of his form of furnace in the provisional specification before referred to.

"This invention consists in the smelting of metallic ores, particularly iron ore, which have been previously mixed with charcoal, by the application of the electric light to that purpose. This is effected by dropping the ore or metal to be melted between the poles of two large electrodes, which are connected in the ordinary manner with a galvanic battery. The electric light thus produced smelts the ore as it passes through it, and the melted metal with the slag falls into a receiver below, where it is kept in a state of fusion by a suitable furnace placed beneath it, the different specific gravities of the slag and melted metal keeping them separate in the receiver."

The specification also describes a modified form of furnace in which the ore to be treated is automatically fed into and through the electric furnace proper. In this form, as will be seen, one of the electrodes is made hollow and contains the mixture of ore and charcoal. Provision is also made for the advance of the electrodes on their consumption in the arc.

This modification is described as follows:

"By another arrangement the two electrodes are placed at a slight angle, and the higher one of the two is made hollow and filled with the ore to be reduced. This ore is gradually pushed forward, as it melts, by a piston and screw rod revolving within the hollow of the electrode. When the whole has been reduced, the piston is withdrawn and the electrode filled again. As the electrodes are consumed, they are caused to advance by screw spindles working into fixed nuts, and attached to armatures or sockets on the end of the electrodes, as by the apparatus a continuous supply of electrodes may be attained in various other ways."

Johnson's electric furnace, differed from any as yet described in the fact that, although the heat employed for the direct fusion and treatment of the ores was purely electric in its origin, there was combined therewith a second furnace in which the fused material collected and separated into molten metal and slag. That is to say, this early form of furnace consisted of the following elements in combination, viz:

(1) An electric furnace proper, the function of which was to directly fuse and treat the ore or other material, by the direct application of the heat of the voltaic arc.

(2) Of a subsidiary or secondary furnace, the function of which was to receive the melted and treated materials, and maintain them at the temperature of fusion until a complete separation was effected of the slag and the molten metal, as a joint result of the action of such heat, and of their differences of density.

The combination of these two elements in an electric furnace, was, considering the date of the invention, exceedingly ingenious. We see no reason why a furnace constructed on the lines here pointed out should not be practical for the smelting or reduction of certain ores.

It is but proper to remark that the name Johnson appended to the provisional specification may be that of the agent to whom the same was intrusted and not that of the inventor. No mention, however, is made in the specification, as is usually done, of the same being a communication, and it is possible that Mr. Johnson was the inventor. The disadvantages of thus taking out the invention in the name of the attorney, in place of that of the inventor are manifest, and require no further comment.

Central High School,
Philadelphia, *January 14th*, 1888.

WATSON AND PROSSER'S ELECTRIC FURNACES.

In the early forms of electric furnaces thus far described, the electric heat has been the sole, or at least the principal source of heat employed. In the forms of furnaces described by J. W. Watson and W. Prosser of England in 1853, the electrical heat formed but an inconsiderable part of the heat employed.

The Watson and Prosser furnaces are described in Brit. Pat. No. 5 of 1853, for "An improved method of manufacturing steel and of carburising iron."

The electric current is employed for the manufacture of steel in three different ways, viz.:—

(1) A mass of molton cast iron is obtained in a suitable furnace or cupola by any of the usual methods. Carbonaceous matter is then added in excess to the metal which combines with it. Two carbon poles, formed of pieces of graphite or gas retort carbon, are then introduced into the mass, and so connected with the powerful battery as to cause its current to pass through the fused metal. Quoting from the specification of this patent.

"We do not begin to pass the current until the cast iron has been in contact with the carbonaceous matter about two hours. The action of the current is to drive off a portion of the carbon combined with the cast iron, and to reduce the hyper-carburet of iron to a carburet of iron containing 1·5 to 1 per cent. of carbon, or, in other words, to a steel of the composition and properties of shear steel, which has been equalised in its texture and composition by repeated tiltings."

The process just described was also useful, it was claimed, in removing the sulphur or phosphorous with which the metal is so frequently contaminated, and whose presence is so injurious to the steel formed thereform.

(2) The converting trough in which the bars of iron are submitted to the process of cementation was insulated, and an electric current passed through the bars of iron while packed in the charcoal or other form of carbon. This is described in the specifications as follows:—

"We insulate by means of non-conducting substances, such as fire-clay and fire lumps, the ordinary converting trough for making bar iron into steel, and then pass an electric current through the whole number of bars in contact with the carbon or charcoal by uniting their separate ends by stout copper wire of not less than half an inch in diameter clamped on to the ends of the bars, which should be permitted to project through the end stones of the cementing troughs about 6 inches. By passing an electric current thus through the bars the operation of steeling is much hastened, since bars which by the ordinary process of cementation require from six to eight days to be made into shear steel, may by the passage of the current be steeled in four or five days."

A curious advantage, in addition to the decrease in the time required is claimed for the electrical cementation of iron. Steel thus formed is, it is claimed, much more uniform in its texture. The steelification is so equalised throughout the mass that the formation of the blisters so common in cemented bars, from the escape of gaseous products, is entirely avoided.

(3) Another process for the formation of steel from iron consists in connecting the mass to be steelified with an electric source by means of poles of graphite or platinum. This is described in the specifications as follows viz:—

"We carburise iron by making the carbonaceous matter in connection with the metal a conductor of electricity by placing poles, either of graphite or platina, into the cementing substance, such as charcoal, the current then passes equally through the mass. By adopting this mode of carburising, a steel of moderate hardness is produced in about two days from the commencement of the cementing process. This steel is highly useful for the manufacture of saws and springs."

The broad idea of using electric currents in substantially some of the ways here indicated for the purposes of improving cast iron, or for converting iron into steel, appears to have repeatedly suggested itself to metallurgists, as a few references will show.

Arthur Wall, in British Patent No. 9,946, of 1843, for "Certain improvements in the manufacture of iron," proposes to subject the iron while in the molten state and while congealing to a current of electricity. He also proposes applying electricity to "iron in a smelting furnace or cupola" by inserting one battery terminal at the top hole, and the other at one of the tuyre holes. He suggests the application of electric curents to "the iron in the puddling or balling furnace." This is effected by connecting one battery terminal with part of the fused metal and the other stirring or balling rod.

F. H. Holmes, in describing, in British Patent No. 573 of 1856, the magnetic-electric machine so well and favourably known in England some time ago, in connection with the name of the inventor, claims the use of the current produced by this machine, as follows:—

"In the manufacture of iron and steel for the purposes of obtaining a better product and in less than the ordinary time" and for "The separation of metals from their ores in any of the ways already proposed for applying the agency of electric currents."

W. H. Dawes, in British Patent No. 1,087 of 1867, for "The manufacture of iron," proposes to pass an electric current through molten iron.

E. C. Monckton, in British Patent No. 1,890 of 1869, for the "Manufacture of iron and steel," proposes "To produce iron direct from the smelting furnace in its greatest purity" by the use of electric currents passed through the molten metal.

Chas. Motier Nes, in British Patent No. 866 of 1871, for the "Manufacture of iron and steel, and re-working of old iron and steel," describes the use of electricity in connection with the various processes mentioned.

Forquignon and Ehrmann, in British Patent No. 2,712 of 1872, for the "Purification of cast iron, malleable iron, cast steel, and malleable steel, &c.," proposes to employ currents from magneto-electric machines to improve the quality of molten metals.

The fact that none of the processes here described for the utilisation of electric currents appear to have been carried into practical operation, does not speak favourably for their efficiency. It does not, however, appear improbable that considerable aid may be afforded to the metallurgist from a slight modification of some of the preceding processes. Such advantages would seem to be indicated in the following general direction, viz.:

(1) The direct formation of certain alloys by making the constituent ingredients thereof the terminals of a sufficiently powerful electric source, and combining them directly through the agency of the voltaic arc taken between them.

(2) The more intimate union of the constituent ingredients of alloys by passing electric currents through them while in the melted state by dipping therein inert electrodes.

(3) The purification of metals by a species of electrolytic separation, by passing electric currents through them while in a melted condition by dipping therein electrodes capable of uniting with the electro-negative, or electro-positive impurities, or with both.

That some of the processes as described, without any modification whatever, may have proved of considerable value, would appear to be quite probable.

Central High School, Philadelphia, *January 21st*, 1888.

C

AMERICAN NOTES.

By DAS TELEPHON.

VERY little that is new in electrical matters has occurred since my last which would be interesting to your home readers. The Bell Telephone Company are not losing any time in calling upon infringers to settle up under the decree of the Supreme Court. The directors, stockholders and subscribers of the Pan telephone were on March 21st served with a notice by the Bell Telephone Company to account to them at once for damages sustained by them through the use of the Pan telephones in the city, and to surrender their telephone instruments and apparatus within five days under penalty of damage suits for infringement. The Pan people have not decided as yet what they will do, but may continue the fight until the question of priority between Gray and Bell, now in the courts, is decided in the court of last resort. Very few Pan telephones are used in the city, the service being confined almost wholly to a few private lines.

Judge Hugh L. Bond, in the United States Circuit Court for the District of Maryland, a day or so ago passed a final decree in favour of the American Bell Telephone Company against Wm. C. Turnbull, of Baltimore, for infringement of the telephone patents of Alexander Graham Bell. Judge Bond, as judge of the United States Circuit Court for the Eastern District of Virginia, passed a final decree in favour of the American Bell Telephone Company against Yates and others, enjoining them from using telephones manufactured and furnished by the Emmer Improved Telephone Company, of Washington, D. C., which are held to infringe the Bell patent. The Supreme Court of the United States has not yet decided upon the motion made by the Solicitor General of the United States to advance the case of the United States *v.* Bell Patent. The question to be finally adjudicated by the United States Supreme Court is whether the United States General has a right to bring an action to vacate a patent on the ground that it was obtained by fraud. I am well convinced that the Court will decide that the United States General has a right to institute such a suit, although there is no express statute conferring such a right, but I am equally confident that should the case be tried to annul the patent, the General will not be able to establish any fraud, and this opinion I have formed after many careful perusals of all the fraudulent charges made. There was no fraud, and Bell's patent will be sustained.

The recently-announced claim of a telegraphic circuit of over 10,000 miles surpassing all previous experiments is somewhat misleading. Many efforts at long circuit work have occurred during the past few years, the distance varying from 4,600 to 8,100 miles. It is a matter of considerable pride to the old operators of the Western Union Telegraph Company in San Francisco that the feat of transmitting clock signals through 7,200 miles of line and talking directly through that same line has never been equalled. The occasion of this feat was the telegraphic determination of the difference of longitude in time between the United States Coast-Survey station in San Francisco and the observatory of the Harvard University at Cambridge in the year 1869. In order to determine the time of transmission of a signal either from the clock (or from the operator's key) over the given length of the line of 3,600 miles, three different methods were devised. One of these was original with Prof. George Davidson, who had charge of the observations. Through the liberality of the management of the Western Union Telegraph Company, a double circuit of line was looped at Cambridge, so that there extended from the San Francisco observatory, 3,600 miles to Cambridge, and the return from Cambridge by a somewhat different route of nearly equal length. The two "earths" were under the San Francisco observatory, distant from each other not more than 10 feet. The line was first opened by an operator in the observatory, and when the last connection was made at Cambridge, the San Francisco operator was considerably astonished to get his own message back within one second of time. Then the astronomical break-circuit clock was thrown into line and made its first break on a pen recording upon a revolving cylinder of paper in the San Francisco observatory, and after this break had traversed the line to Cambridge it returned and made a break upon a second pen moving parallel with the former in about eight-tenths of a second of time. This was continued every second for several minutes, and was repeated upon several nights, and when one of the twelve batteries in this long circuit was removed, the wave length time was reduced to only sixty-five hundredths of a second. Telegraphic conversation was, of course, carried on at the same rate of speed. This feat over a line 7,200 miles in length has been unrivalled up to the present time, both as a practical working exhibit and a scientific success.

THE ELECTRIC LIGHTING ACT (1882) AMENDMENT BILL.

THE House of Lords went into Committee upon Lord Thurlow's Bill on Monday.

On Clause 2,

The Earl of CAMPERDOWN moved to omit the words "The goodwill of the business and of" on the ground that they rendered uncertain the elements of value in the property of the companies to be taken over. He desired at the same time that at the expiration of the period during which the companies' privileges were to endure their plant and material should be valued as being *in situ* and as suitable for the purposes for which they were intended, instead of being taken over at the "old iron" value.

The Earl of CRAWFORD observed that inasmuch as it was understood that the noble and learned lord opposite intended to propose an amendment upon this clause, it would be convenient if he would now state the effect of that amendment.

Lord HERSCHELL said that the effect of his proposed amendment would be to insure that at the expiration of the companies' term their plant should be taken over at the price it would fetch as being ready for immediate working.

Viscount BURY hoped that the word "goodwill" would not be omitted from the Bill. When the measure was before the Select Committee the Committee appeared to be divided into two parties—one in favour of giving the companies a right to the value of their goodwill, and the other in favour of treating their businesses as those of breaking-up concerns.

The Earl of CRAWFORD said that in justice to the public they should make it clear when the companies would no longer be justified in putting fresh capital into their works for the purpose of keeping them in going order.

The Marquis of SALISBURY confessed that his first view with respect to a matter of this kind was that if compulsory powers for purchase of a going concern were enacted the full value of the going concern at the time of purchase ought to be given. He did not see that there was any reason why the electric lighting companies should be burdened with burdens different from those placed upon other industries; but as he understood that the companies themselves were willing that these words should be left out, the House would be justified in agreeing to the motion. At the same time he wished to state that he did not assent to the view either on the one hand that this industry should be subjected to greater burdens than were imposed upon others, or on the other that they were entitled to any special preference.

Lord HERSCHELL observed that he agreed with very much that the noble marquis had said. He had always thought it desirable to provide against unreasonable terms being required if the local authorities wished to purchase these undertakings, but he had never seen any reason why special burdens should be imposed upon the undertakers. If the condition were imposed upon them that at the end of any given term they should not receive the full value of their property, they would recoup themselves in some other way, as by making higher charges. The present generation would thus pay more for the electric light, in order that some 30 or 40 years hence the next generation should have it for less than they ought to pay. At the same time he recognised the difficulties of the situation, and if the Bill could not be got through without, he agreed that the word "goodwill" should be struck out of this clause. He would prefer that instead of the term "goodwill," the words "market value" should be substituted.

Lord THURLOW said he was quite willing to assent to the motion. It was essential for the passage of the Bill through another place that the word "goodwill" should not be in it. What he dreaded was that unless the purchase of these undertakings was made a fair one—and more than fair, liberal—during the last few years of the term the undertakers would be tempted to do what was called scamp the undertaking. He had consulted the representatives of most of the London and provincial electric lighting companies, and he had come to the conclusion that the prolongation of the term from 21 years to 42 years, as now proposed would be sufficient to insure the public against overcharge. On behalf of the companies he was authorised to accept this amendment, as they were satisfied that the prolongation of the term would bring capital into the business.

The amendment was then agreed to, as were some consequential amendments.

Viscount BURY wished to draw the attention of the noble lord opposite to the provision that on the purchase of an undertaking the purchaser should get a clear title without the seller having to make one. This would absolve the local authority from the necessity of investigating the title to see whether it was free from mortgages. He should like to ask what would become of mortgagees and other creditors.

Lord THURLOW did not think that any difficulty such as that suggested by the noble viscount would arise. At the same time he might say that he was not responsible for these words in the clause.

The clause was then agreed to.

The other clauses were also, with some amendments, agreed to, and the Bill passed through committee, and bids fair to shortly become law.

An Interesting Experiment.—The Pittsburg Electric Railway Company, finding its line blocked with snow, ordered a large quantity of salt to be thrown along the line so as to dissolve it. The conductors working at a difference of potential of 500 volts were carried in wooden troughs, and the melting snow and salt speedily established a circuit between the conductors with the result of setting fire to the troughs. Surely Mr. Holroyd Smith's famous method of testing the Blackpool line ought to have been a lesson to our Pittsburg friends.

REVIEWS.

A Treatise on Electricity and Magnetism. By E. MASCART and J. JOUBERT. Translated by F. ATKINSON, Ph.D., F.C.S. Vol. II. *Methods of Measurement and Applications.* London: Thos. De La Rue & Co.

This second volume of Messrs. Mascart and Joubert's Treatise will be welcome to many, though, like the first volume, it is a work only adapted for advanced students. A somewhat unsatisfactory feature in works of the kind is the fact that so very much is left for the student to work out for himself (if he can), the results only of investigations being given. The work is divided into four parts, viz., "Methods of Measurement," "Electrical Measurements," "Magnetic Measurements," and "Complement." In Part I. there are five chapters, dealing respectively with "Measurement of Angles," "Measurement of Oscillations," "Measurement of Couples," "Properties of Circular Currents," "Coefficients of Induction." The measurement of angles is an important subject in its relation to galvanometry, but it may be questioned whether the authors have not in some respects padded out the subject unnecessarily, and in other respects cut it too short. In the next chapter "Measurement of Oscillations" is dealt with, the well-known method of Gauss, which was published in 1837, concluding the subject. We next have "Measurement of Couples," an important subject, as the effects of torsion and the theory of the bifilar suspension come under its head. Under the heading "Properties of Circular Currents," the theory of the construction of galvanometer coils is dealt with, though the authors do not appear to have made much advance on what Clerk-Maxwell has written on the subject. In Chapter V. "Coefficients of Induction" are treated of; this subject within the last year or two seems to have been very catching, as there have been few electricians who have not had something to say with regard to it, and, it must be confessed, few have understood it. Messrs. Mascart and Joubert devote over 50 pages to the question, though little information of any value to the practical electrician can be gleaned.

Part II. deals, as we have stated, with "Electrical Measurements," and we have chapters on "Electrometry," "Measurement of Currents," "Comparison of Resistances," "Measurement of Electromotive Forces," "Measurement of Capacity," "Constants of Coils," "Measurement of Resistances in Absolute Value," "Ratio of Units." Practical electricians who may expect to obtain some wrinkles of use to them from this chapter will be disappointed; in fact, the authors throughout do not indicate the practical value of their investigations, leaving this, we presume, to be found out by the students of their writing. It is rarely that theorists have the power of going beyond theory, and Messrs. Mascart and Joubert are no exceptions to this rule. With reference to ballistic galvanometers, the authors remark that the use of shunts in such galvanometers may give rise to serious errors; the well-known investigation made by Mr. Latimer Clark in the case of discharge deflections made with an ordinary reflecting galvanometer showed a decided error to exist, and this error is probably much greater in the case of a ballistic galvanometer with a large and heavy needle; here we have a case where an investigation showing the magnitude of the possible error would be of great practical value, but the authors are silent on the subject. The "Measurement of Resistances" does not call for much remark, though the arrangement of the matter and the meagreness of the explanations leave something to be desired. The Wheatstone bridge, however, is dealt with at some length. Speaking of the measurement of the insulation of a cable the authors state that we have "the charge of a cable acting as condenser, the current which corresponds to the phenomenon of electric absorption, and finally the leakage of the cable. The first rapidly ceases, the second lasts a shorter or longer time, the third alone is permanent; *the resistance is deduced from the intensity of this latter.*" The italics are our own; comment is hardly necessary. In discussing "Electromotive Forces" the authors make no reference to the important work of Prof. Oliver Lodge on the "Seat of Electromotive Force in a Galvanic Cell," though they allude to the general subject.

Taking the work as a whole, we are somewhat disappointed with it. There is much in it which is highly to be praised, no doubt; but there is much wanting, especially when practical details are touched upon.

Phenomènes Electriques de l'Atmosphere. By GASTON PLANTE. Paris: Librairie, J. B. Baillière et Fils, 19, Rue Hautefeuille.

Much, if not most, of the matter in this work of Mr. Planté is old; indeed, a great deal appeared in early numbers of the ELECTRICAL REVIEW. The subject is one which M. Planté has made peculiarly his own, and it is decidedly an interesting subject, though a special more than a general one. We are somewhat inclined to think, however, that the attribution of nearly all meteorological phenomena to electrical action has been carried too far, though no doubt there is much to be said in its support.

OBITUARY.

MR. T. R. CRAMPTON.

HOW many memories of things said and done in the past recur to our minds when an announcement occurs, such as that which appears in the *Times* of Monday last, relative to the death of Thomas Russell Crampton, M.Inst.C.E. Our thoughts at once single out from many other scenes, the deck of the steam tug *Goliath* where on a fine day in August, 1850, were gathered a small party busily engaged in laying a line of telegraph from Dover to Calais for the purpose of proving the practicability of submarine telegraphy. While those engaged in the actual work were busy, Crampton's fine manly figure in caped coat and Glengarry cap, was the centre of a group of friends speculating as to the chances of Louis Napoleon becoming Emperor of France, Louis Phillipe having just died in England, an exile.

We believe that only Mr. Wollaston and Mr. Willoughby Smith are left to us now of the pioneers who were on that steamer on that memorable occasion.

Mr. F. C. Webb was in the navy in those days and attached to the Government steamer that accompanied the *Goliath*, and he did good service in taking soundings and marking positions.

Mr. Crampton was a member of the Society of Telegraph-Engineers and Electricians, and had served on its Council, where his straightforward manner and manly presence will be much missed.

MAJOR KNAPP BARROW.

We much regret to see in the *Times* of the 24th inst. the announcement of the death of Major Knapp Barrow, C.M.G., at the comparatively early age of 53.

Major Barrow was a good soldier, who took a great interest in electric telegraphy. When quartered at Chatham with the late Col. Sir Francis Bolton in 1865 the two were busy compiling a code, which they felt sure would have to be used if ever telegraphy was established between England and America. After experimenting through 1,200 miles of coiled cable on board the *Great Eastern*, then moored in the Medway, Mr. Willoughby Smith advised that no agreement as to the means of working the cable should be entertained until it was laid, and he then saw what could be done with their own instruments.

When the cable was laid it was soon found that no code was required, but that the speed of working was simply limited to the capacity of hand of the sender or the eye of the receiver.

A few years after this an attempt was made, by mooring a signal station in the form of a ship 60 miles from the Land's End and laying a cable from this signal station to the shore, to keep up telegraphic communication; but owing to the great difficulty in maintaining this communication the whole thing was abandoned. It perhaps is only in accordance with the constant anomalies to be met with in telegraphy that the idea conceived and planned by a sailor was entrusted to the management of poor Barrow, who was a soldier, and knew very little of nautical matters. Only one more instance of the round peg in the square hole so often noticed in telegraphic work.

NOTES.

The City and Electric Lighting.—A special meeting of the Commission of Sewers was held at the Guildhall on Wednesday last week to consider a letter from the Remembrancer relative to the application of the South Metropolitan Electric Light Company to the Board of Trade for a provisional order. The Chairman said the Remembrancer would read a letter from the Parliamentary agents to the South Metropolitan Electric Light Company, enclosing copy of a letter from the Board of Trade stating that it was proposed to consider objections to the licence at 11 o'clock on Friday, when the representatives of the Commission of Sewers were requested to attend. The chairman said on the last occasion a resolution was passed by the commission instructing the Remembrancer to lodge objections to several Bills in Parliament, this being one. The Remembrancer did lodge objections accordingly. The area laid down by the company included part of the area called the Blackfriars site, with regard to which the Commissioners were at the time in negotiation with the Brush Company. This was one of the choicest sites in the whole metropolis for electric light, comprising all the newspaper offices. Since then the Commission had declined to go further with the Brush contract; therefore an important factor in their application was removed. They had already four applications before the Commission or its committees from four electric lighting companies, with offers to light the whole or a portion of the City. The Remembrancer (Mr. Goldney) said the previous evening one of the firm of Messrs. Bircham and Company, Parliamentary agents acting for the South Metropolitan Electric Light Company, called upon him to intimate generally that he thought the company might be disposed to discuss terms or meet the objections of the Commission. He (the Remembrancer) intimated to him that the Commission had powers under their own Acts to undertake the whole of the electric lighting themselves. He had since received a letter from the Parliamentary agents asking if it would be satisfactory to the Commission if a clause were inserted to the effect that the powers of the company in the Blackfriars district might be hereafter annulled at the request of the Commission. The chairman was about to read the objections of the Commission, when the engineer (Colonel Haywood) suggested that they ought to be taken with closed doors. This was agreed to, and the rest of the sitting was *in camera*.

Bank Lighting at Leamington.—Messrs. Chamberlain and Hookham, of the Midland Electric Lighting Company, have received an order from Messrs. Lloyd, Barnett, and Bosanquet, bankers, to lay the electric light into their bank premises on the Parade at Leamington.

Domestic Electric Lighting.—Sir Francis Truscott, of East Grinstead, has taken considerable interest in electric lighting. He rides about in a carriage which contains a glow lamp lighted by means of an accumulator, and his house and grounds have been fitted with the most improved methods of electric lighting.

The Electric Light and Naval Warfare.—The professional advisers of the Admiralty have urged upon the board the necessity for immediately equipping all vessels of war with suitable electric lighting apparatus. An order has now been issued that every vessel in the British Navy is to be so fitted, provided that the boilers are in a sufficiently good condition to admit of the requisite pressure being maintained, and no ship is to be constructed in the future without provision being made for at least four stations from which to project electric light rays. An officer specially appointed will supervise all electric fittings in ships of war dealt with in home dockyards, and the leads and main cables for conveying the current are to be most carefully insulated, and in no case carried near the powder magazines.

Exeter and the Electric Light.—The Right Worshipful the Mayor of Exeter (Mr. C. T. K. Roberts) presided over a private meeting of the Town Council at the Guildhall, on Wednesday last week, convened for the purpose of considering the advisability of lighting the city by electricity. A large number of members were in favour of recommending the adoption of the electric light as an illuminant of the main streets of the city, whilst others opposed it chiefly on the ground that it would be unfair, in the face of existent burdens, to load the ratepayers with the cost of an experiment which might after all turn out a failure. Mr. Massingham, the agent of the Thomson-Houston system, with which the main streets of the city have been lit for some months, was called in, and, in answer to questions put to him by the members, stated that he was prepared to light a quarter of the city from St. Anne's Chapel to Exe Bridge, taking in Queen Street, Bedford Circus, Fore Street, South Street, North Street, and Magdalen Street, with forty arc lamps, which together would give a light equal to 48,000 candle-power, for £800 a year—£20 a year for each lamp. The light would be kept on about ten hours a day, from dusk to daylight. He pointed out that the area he had mentioned was at present lit by 207 gas lamps, which gave a light of about 3,700 candle-power, and cost £809 7s. 4d. per year. A resolution was then proposed and seconded to the effect that in consideration of the present financial state of the city the committee recommended that the proposal to light the city by electricity be not adopted. To this an amendment was proposed to the effect that the various electric lighting companies be invited to inform the committee the price at which they would be prepared to make an installation for the purpose of lighting the city. On being put the amendment was carried by a majority of about half a dozen. A rider was then proposed to the effect that in the event of the price of electricity not being greater than was at present paid for gas the committee recommend to the council the adoption of the first-named illuminant. This was carried *nem. con.* and the proceedings terminated.

Electric Lighting of the Brussels Exhibition.—The illumination of the Brussels Exhibition is divided into three sections, viz. :—the lighting of the buildings by electricity, the lighting of the fountains by the same means, and the lighting of the gardens by gas. For the last-named purpose 20,000 gas jets will be employed.

The First to Bring the Electric Light to London.—The indefatigable interviewer of the *Star* paid a visit recently to "Niagara in London," and succeeded in button-holeing Mr. John Hollingshead. After discussing various topics the interviewer remarked, "You were also the first, I believe, to bring the electric light to the theatre?" to which the veteran manager replied: "Yes; and more than that, I was the first to bring it to London. The electric light had never been seen in London until the night when six arc lamps appeared outside the Gaiety." When Mr. Hollingshead claims more than to have been the first to use arc lights in connection with a London theatre, he goes too far.

Electric Light Estimates.—With regard to the estimates of various electric lighting firms received by the borough surveyor of Chelsea, and which have been published by some of our contemporaries, we are desired by Messrs. Drake and Gorham to insert the following communication from them :—"As it would appear from the account of the borough surveyor that although we are manufacturers of accumulators we do not ourselves employ them in our own electric light installations, we would point out that this is far from being the case ; in fact, we were somewhat annoyed at the construction which had been put on our proposal, as we had gathered that the chief consideration with regard to this lighting was low first cost and economy of maintenance, and that an accumulator scheme was not wanted. Under these circumstances we pointed out that it would be unsafe to rely upon one engine, and that a second would be necessary. Our estimate for maintenance was also made higher owing to the number of tons of coal which we mentioned being kept the same whereas a better quality of coal was to be used. This would, of course, have materially reduced the consumption of coal for a given return so that the coal should have been left as we put it in our estimate when our maintenance would have come out £16 lower than given. There is, of course, no question that a more efficient system of lighting would be provided by the adoption of accumulators, but the expense of the lighting would necessarily have been a trifle higher, both in first cost and maintenance.

Theatre Lighting in Paris.—The electric light installation at the Opéra Comique comprises 503 incandescence lamps distributed as follows :—Chandelier, 192 ; management, 17 ; passsages, stairs, and offices, 120 ; lobbies, 108 ; boxes, 50 ; passages, 36. The current is supplied from machines constructed by the Châtelet Company.

The Odéon Theatre has an installation of 1,200 incandescence lamps supplied from three dynamos capable of supplying 500 lamps each. The motive power is furnished by three Weyher and Richmond engines of 70 H.P. The work was carried out by the Edison Company.

Electric Lighting at Boulogne.—The Casino at Boulogne has been lately fitted up with the electric light ; 700 incandescent lamps supply the lighting for the interior of the building, while the gardens are illuminated by 30 arc lights. Two Edison dynamos furnish the current. The installation has been effected by the Edison Continental Company.

The Electric Light at Southampton.—The recent experiments which were carried out at Southampton by Mr. W. B. G. Bennett, the borough surveyor, with the view of testing the possibility of utilising the spare motive power at the refuse destructor for electric lighting purposes having proved thoroughly successful, the special and general works committee of the Corporation have made a recommendation that the proposed lighting by electricity of the Audit House, Hartley Institution (subject to the consent of the governing council), the Guildhall, the clock at Holyrood Church, the lamp at the top of Bridgest, the Corporation Wharf, and the streets in the vicinity thereof, shall be carried out, and that the Town Clerk shall be instructed to apply to the Local Government Board for sanction to borrow £1,440, the estimated cost of the necessary dynamos, accumulators, appliances, fittings, &c., for a period not exceeding 20 years. At the recent experimental installation, the works in connection with the refuse works were fitted up with incandescent lights of 16 C.P., while the yard was illuminated with an elevated arc lamp of 3,000 C.P. Three other lamps of the same kind were fixed at intervals along the streets of Chapel. The borough surveyor now estimates the cost of lighting the Municipal Offices, Hartley Institution, Guildhall, &c., at £84 per annum, and the lighting of the streets at Chapel, including the Corporation Wharf, at £67 per annum. It is pointed out that there is sufficient steam power at the Corporation Works to light the principal streets in the town, and as the idea of electric lighting has already been favourably received in Southampton, further developments may be expected.

Telephone Line between Paris and Marseilles—We gather from *La Lumière Electrique* that the completion of the telephone line between Paris-Lyons-Marseilles, may be shortly expected. The Marseilles-Lyons section is expected to be opened to the public about the middle of May, and the Lyons-Paris portion about the middle of June.

Telephone in Egypt.—The Cairo Telephone Company has been obliged to abandon its scheme for uniting Alexandria and Cairo by the telephone, owing to the extremely severe conditions imposed by the Egyptian Telegraph Administration. It is said that the Government has itself the intention of shortly establishing the above mentioned communication, employing for the purpose some of the telegraph wires already erected.

United Telephone Company.—Mr. Frederick Richard Leyland, who is a director of the Swan United, and Edison and Swan United Electric Light Companies, has been elected a director of the United Telephone Company in the room of the late Mr. E. Dwyer Gray, M.P.

The Telephone over the Border.—The list of subscribers to the Telephone Exchange in Galashiels continues to grow, and we understand that a line will be erected to Melrose, and a branch Exchange opened in that town early in May.

The Writing Telegraph.—Mr. M'Ewan asked the Postmaster-General on Monday whether it was true that, after six months' consideration, the Post Office authorities had refused to grant a licence to the proprietors of the Writing Telegraph to use their system under the same conditions as the various telephone companies use their systems ; and whether, if it be true, this was in accordance with the usage in respect to other companies desiring to use telegraph systems. Sir H. Maxwell : I am requested by my right hon. friend to say, in reply to the hon. member, that it is the fact, that after due consideration, he has refused to grant a licence to the proprietors of the Writing Telegraph. He thinks it preferable that, if there is a substantial demand for the establishment of exchanges to be worked by that instrument, they should be in the hands of the Post Office, the instruments being supplied by the proprietors on terms to be arranged.

Italian Telegraphs.—The Italian Ministry of Public Works has decided upon constructing two new telegraph lines between Rome and Naples, and between Rome and Pisa. The estimated cost is about £56,000.

Telegraph Convention with the Chinese Government.—The Great Northern and the Eastern Telegraph Companies have signed a convention with the Chinese Government for the partition between them of telegraphic communications with China. The Chinese Government, notwithstanding the active measures taken at Pekin by the companies interested, has not yet ratified the agreement. The convention is to remain in force for 16 years, and has been entered into owing to the extension of the Chinese telegraph system, and to prevent competition.

The Submarine Telegraph Act.—Notice is given by the Board of Trade that the Submarine Telegraph Act, 1885 (48 and 49 Vict., cap. 49), will come into force on May 1st next.

The Royal Society.—At the meeting yesterday afternoon a paper was announced to be read by Prof. J. C. Ewart on the development of the electric organ of *Raia batis*.

The Proposed Pacific Ocean Cable.—We have received the accompanying amended statement of the suggested routes for the Pacific cable, the proposals for which are now under the consideration of the Imperial, Colonial and United States Governments:—

Landing places.	Distances, nautical miles.	Length of cable.	Estimated cost at £700 per mile, laid.	Average soundings (in fathoms).	Nature of ocean bed.
Route projected by F. N. GISBORNE, *C.E. and Electrician.*					
Vancouver Island, British Columbia, to Unimak, Aleutian Islands	1,350	1,485	$1,039,500	2,000 to 2,800	Ooze, mud and sand.
Unimak to Alton, Aleutian Islands	800	880	616,000	Not sounded. Probably 100 to 200	„ „ „
Alton to Yezzo, Japan	1,300	1,430	1,001,000	2,700 to 3,000	„ „ „
Totals ...	3,450	3,795	$2,656,500		
Route projected by S. FLEMING, *C.E.*					
Vancouver Island, B.C., to Honolulu, Sandwich Islands	2,300	2,530 [?]	$1,771,000	2,000 to 3,100	Ooze, mud and clay.
Honolulu to Fanning Island...	1,040	1,145	801,500	1,300 to 3,000	„ „ „
Fanning Island to Vanua Lavu, Fiji Islands	1,674	1,841	1,288,700	2,000 to 3,300	„ „ „
Vanua Lavu to Brisbane, Australia	1,486	1,684	1,143,800	930 to 2,600	„ „ „
Totals ...	6,500	7,150	$5,005,000		
Route projected by C. W. FIELD, *Merchant.*					
San Francisco, Col., to Honolulu, Sandwich Islands ...	2,070	2,277	$1,593,500	2,000 to 3,120	Ooze, mud and clay.
Honolulu to Morell Island	1,500	1,650	1,155,000	1,500 to 3,100	„ lava and clay.
Morell Island to Nipon, Japan	1,800	1,980	1,386,000	2,700 to 3,000	„ mud and clay.
Totals ...	5,370	5,907	$4,134,500		

N.B.—Actual rate of working speeds attained through existing cables:—
French Atlantic: Brest to St. Pierre, 2,584 miles (nautical), 15 words per minute.
Anglo-American Cables: 1,896 and 1,857 miles (nautical), 17 words per minute, and 25 maximum, experimentally.
The estimated speed of a cable of 1,500 nautical miles being 33 words per minute with a maximum of the highest rate attainable by an operator.

Glasgow International Exhibition.—The Glasgow Exhibition, which is to be formally opened by the Prince and Princess of Wales on the 8th of May, was thrown open for a preliminary inspection by representatives of the Press on Saturday last. It was expected that the electric light installation would be ready for a preliminary run, but something went wrong, and though the engines were started the lights were not switched on. Among the electrical apaliances already at work are some telephones of the Swiss Ericsson-Bell Company. Preparation is being made at the stand of Messrs. J. and P. Coats to exhibit spooling and winding machines in motion driven by electricity, and there will no doubt be many items of great interest irrespective of the lighting. We note that the house containing the engines and dynamos for the fairy fountains is to be lighted with Siemens's gas lamps. On the Kelvin, which has been deepened for the occasion, will be shown steam and electric launches and a real gondola. It is said that when the proposition was made as to importing the latter a worthy member of the Glasgow Town Council, under the impression that it was some rare bird, suggested that it would be better to have two, that they might breed.

Munro and Jamieson's Electrical Rules and Tables (Fifth Edition).—A new edition, with several important additions and all mistakes pointed out in the fourth edition of this useful, indispensable electricians' pocket-book eliminated, has just appeared. This little book has now become fairly established amongst electrical engineers, in the same way that "Molesworth's Engineering Pocket-book" has amongst engineers, and consequently every one who observes an omission or points out a useful addition to it is doing the profession a service.

Submarine Boat.—Mr. Chapman and the Brothers Brin have, it is stated, recently invented a new type of submarine boat, the propulsion of which is effected by the combustion of a mixture of compressed oxygen and petroleum spray, either in a gas engine, or in the furnace of a steam boiler. The oxygen is compressed to 80 atmospheres, at which pressure a considerable quantity can be stored in a comparatively small space. The immersion of the vessel is effected by a centrifugal pump which draws in water at the bottom of the boat, and forces it out vertically through two reaction tubes. The depth of immersion is automatically controlled by means of electricity.

Theatre Fires.—On Thursday last week a panic occurred at the Theatre du Capitole, Toulouse. At the commencement of the second act cries of "Fire!" were raised, and there was immediately a great rush for the doors on the part of the audience. Eventually, however, the alarm was appeased, and it transpired that a rag which had been carelessly left near a gas burner had commenced to smoulder and occasioned clouds of smoke. "It would," says the *Petit Journal*, "have been singularly unfortunate if the fire had proved serious, for on the following Sunday the installation of the electric light in the theatre was to be inaugurated."

The Grantham Theatre was burnt down on Sunday morning, but it is suspected that this conflagration was the result of incendiarism, from which the strictest precautions and the most perfect means of illumination cannot secure immunity.

Kensington and Underground Wires.—At a meeting of the Kensington Vestry on April 18th, the Works Committee reported that they had again considered the application by the Kensington Court Electric Light Company for permission to open the footpath in parts of Kensington High Street for laying wires, and a proposal for running wires in a portion of the route through the sewers, and recommended that permission be granted on condition that the work is carried out at night in places where interference with trade, &c., would otherwise result, and that it be executed to the satisfaction of the vestry's surveyor. Mr. Braye moved that it be referred back for the Works Committee to reconsider. Mr. Oliver seconded, and this was carried.

Incandescence Filaments. — In testing chemically certain filaments said to be of a material other than carbon, Mr. Desmond Fitz-Gerald, the *Electrical Engineer* states, boiled them in strong sulphuric acid, with the view, if carbon were present, of obtaining carbonic oxide and sulphurous acid according to the reaction

$$H_2SO_4 + C = CO + H_2SO_3.$$

No such reaction occurred; the filaments in question remaining unaltered. Before committing himself, however, to the conclusion that no carbon was present, the experimenter took the precaution of repeating the experiment with filaments known to be of carbon. These filaments also remained unaltered after prolonged boiling in the acid. This result justifies the conclusion that the carbon of lamp filaments, unlike ordinary carbon, is not acted upon by sulphuric acid at its boiling point.

Antiquated English Insurance.—English electrical engineers and contractors, says the New York *Electrical Review*, are threatened with a horrible tangle by the ridiculous action of the various fire insurance companies. The Phœnix is no longer the standard; another set of rules has appeared, and others are threatened. What a mess must follow such absurd methods. It will destroy the electric lighting business in London. Just imagine the task of installing a plant in a building on which half a dozen companies have risks written, each company requiring in its policy that certain rules must be adopted in case of electric lighting, and each company having a different set of rules from the rest. It's enough to make the spirit of the age pause and weep. But probably this spirit has no dominion over the English insurance interests: they must still be under the wings of the almost forgotten spectre of the last century. In this country insurance companies are wide awake, and they help the advance of electrical science rather than retard it, and this example ought to be followed abroad.

Information Required. — A correspondent would like to receive information from anyone connected with naval electrical engineering with regard to joining the Navy for the purpose of becoming an electrical engineer.

Society of Telegraph-Engineers and Electricians.—A students' meeting was held on Friday, April 20th, in the Society's Library, Mr. Alexander Siemens, Vice-President, in the Chair. Mr. E. George Tidd read a paper upon "The Use of Electricity for Theatre Lighting." The writer in his opening remarks pointed out the advantages of the light in our public places of entertainment and the practical methods of working it; he then proceeded to give a full and detailed description of all the installations in our various London theatres. The writer stated that the following ten theatres and music halls were wholly or partially lighted by electricity, viz.:—Savoy, Criterion, Gaiety, Prince of Wales', Haymarket, Terry's, Pavilion, Alhambra, Oxford and the Empire; and that now it was in process of installation at the Adelphi. Of these he considered the Criterion and Savoy the most perfect, each having its own plant, which had worked satisfactorily without any break or interruption, the former for over four years and the latter seven years. Of the remainder, six have the current supplied from the Grosvenor Gallery, and the Alhambra and Pavilion have plant of their own, but only employed for lighting the auditorium. He referred to the Oxford as the most recent specimen of wiring, following the Fire Office rules as closely as possible. The paper was illustrated by diagrams and by apparatus kindly lent by Messrs. E. L. Berry & Co. A discussion followed, in which Messrs. Sanders, G. W. Smith, Dykes Rance and Lamb took part, and after Mr. Tidd's reply, the Chairman made a few remarks.

The Irish Exhibition.—This exhibition, which is to be held at Olympia, West Kensington, will be opened on June 4th. The preparations may be said to have scarcely commenced yet; but, as far as the building itself is concerned, there is little to be done, and it will rest with the exhibitors to make the show complete by the opening day.

Banquet to Sir John Pender.—Sir John Pender was entertained on Monday evening by representatives of the leading submarine telegraph companies and many distinguished persons with whom he has come into contact in the discharge of his duties, at a banquet at the Hotel Métropole, to celebrate his knighthood. The Earl of Derby occupied the chair; the usual toasts were honoured; and a presentation was made to Lady Pender, through Sir John, of a portrait of her husband by Prof. Herkomer, R.A.

The House-to-House Electric Supply Company, Limited.—We are informed that Mr. A. P. Trotter has resigned the position which he held with this company.

Right of Way for Electric Light Companies.—The Cincinnati Board of Public Works is considering an ordinance granting the right of way over streets and public grounds to any electric light company, on condition of payment to the city of 1 per cent. of the company's gross revenue.

Prize for an Electrical Paper.—The Belgian Society of Electricians has offered a prize of £10 for the best popular essay on the elementary principles of electricity. Mathematical formulæ need not be employed, nor is it necessary to demonstrate the fundamental laws. The fact that the essay must be written in French places the majority of English electricians out of the race for this munificent award.

Brussels Exhibition.—We learn that the United States Government has voted a sum of $30,000 for the assistance of American exhibitors at the Brussels Exhibition. We also notice that of the 72 countries and colonies which have signified their adhesion to the proposals of the Brussels International Conference on Customs Tariffs no less than 26 are British.

The Copper Market.—We read in *Industries* that the syndicate is still able to keep up, in Paris, the high price of copper, though the stock is accumulating and the consumption very much restricted. In Vienna the demand for copper has been brisk, but chiefly supplied from stocks of old copper. The purchases of new copper are on a very limited scale, the idea gaining ground that the present high prices cannot be much longer maintained. In New York the copper market shows signs of declining prices. In the English markets the price is still kept up, but there is a fall for forward deliveries, and the stocks are rapidly augmenting. Though the syndicate has captured nearly all of the large producers of copper, and most of the English smelters and manufacturers, the trade is stagnant, since consumers hold aloof.

Stimulus to Underground Work. — The severe storms experienced during this winter, and the consequent failure of nearly all overhead lines in New York, has had the effect of supplying a good argument in favour of underground wires. These exceptionally heavy storms occur upon an average once every five years, and the restoration of communications is a slow process and entails a very serious outlay.

Something Else Wanted.—Some inventive genius has suggested the connecting of the chief seaboard cities on the American coast by means of submarine cables in order to avoid the paralysing of business consequent upon the very general breaking down of overhead lines during this winter's storms. The *Electrical Engineer* of New York points out that such a scheme would not be of much use, since the stopping of business resulted from the blocking of all means of transportation, and that business could not possibly be carried on until some means are devised for obviating this impediment.

Advantages of Underground Work.—The inhabitants of Boston are not likely to look with a very friendly eye upon the ever-increasing schemes brought forward by inventive genius. As it is their streets are likely to be torn up for a long time to come by the laying down of the hot water supply mains, by the construction of conduits for telegraph, telephone, and electric light wires, and by the cable road enterprises.

Mr. A. Reckenzaun.—The friends of this distinguished engineer will be pleased to learn that he has just returned in excellent health from America, where he went in May last to fulfil a four months' professional engagement. That the time has been extended to nearly a year shows how much his technical knowledge has been appreciated by our trans-Atlantic cousins. He speaks very highly of the people and the country, and American electricians will find in him a warm advocate of their energy and enterprise.

Tapping a Tram Line.—The Town Council of Blackpool has declined to grant an application from Mr. Thomas Needham for permission to tap the electric tramway line and take the current under the street, or to carry wires over the Corporation's land for the purposes of a machine for an out-door amusement. The Deputy-Mayor, referring to this application, said that some years ago an Act was passed enabling the Corporation to light the town by electricity, but they had never acted on it. Were they compromising their powers, he asked, by allowing other people to put up an electric light. The Town Clerk replied that the light referred to did not interfere with the powers of the Corporation.

Transactions.—The March number of the *Transactions* of the American Institute of Electrical Engineers, just to hand, contains Mr. Willard E. Case's paper on "Electric Energy from Carbon without Heat," and the discussion thereupon, and a very full index of current electrical literature. No. 71 of the *Journal* of the English Society of Telegraph-Engineers and Electricians contains the papers by Mr. Gisbert Kapp, Mr. J. Kenneth D. Mackenzie, and Prof. George Forbes on "Alternate-Current Transformers, with special reference to the Best Proportion between Iron and Copper," "The Distribution of Electricity by means of Secondary Generators or Transformers," and "Formulæ for Converters," and the discussion upon those papers, which alone occupied two evenings, the papers having all been read at a previous meeting; an orginal communication by Mr. E. O. Walker on "Earth Currents in India;" abstracts from foreign periodicals; and a list of articles relating to electricity and magnetism appearing in some of the principal technical journals during the month of January.

Living Current Indicator.—A correspondent sends the following:—"I believe there is a demand for a simple and efficient current indicator. How far will this go towards supplying the demand?—

A German paper publishes a curious experiment by Prof. L. Herman, the physiologist. He placed a number of tadpoles in a basin of water, and submitted them to the action of the current from a small electric battery, with the result that they acted as magnetised needles would under similar conditions—that is to say, they exhibited a decided polarity. Their heads pointed towards one of the wires, but when the current was reversed they immediately turned their bodies, and pointed the other way. If this be true the curious conclusion is arrived at that a telegraphic message could be deciphered through the medium of living tadpoles in lieu of magnetised needles.

Would it not be possible to form another electrical company or syndicate for working this, and breeding the tad-poles?"

A New Frictional Machine.—At a recent meeting of the Liverpool Chemists' Association Dr. Symes exhibited and described Mr. Tudsbury's new double-cylinder electric machine for the generation of frictional electricity. It is a modification of the Wimshurst influence machine. Wimshurst's machine, as our readers know, consists of two plates of glass, the surfaces of which are brought near together, but do not touch each other; they are caused to revolve rapidly in opposite directions. The modified machine of Mr. Tudsbury is made of ebonite, in the form of two cylinders, very much in appearance like two sieves revolving one inside the other, the sectors being placed transversely across the hoop. This machine, the smaller patterns of which would prove admirably adapted for medical use, is also fitted with a new double high-tension discharge, whereby the length of spark obtainable is considerably increased. Glass machines all give positive electricity; the new ebonite apparatus will yield negative electricity in the same manner.

Society of Arts.—At the Wednesday evening meeting of May 16th, Mr. R. E. B. Crompton is announced to read a paper on "Electric Lighting from Central Stations," under the presidency of the Attorney-General (Sir Richard Webster, M.P.).

Large Switchboards.—The United Electrical Engineering Company has just constructed a splendid switchboard to the order of the Aluminium Syndicate for the works of the latter. The switchboard, which measures 11 feet by 4 feet, has been built under the direction of Mr. Nevile to govern the current from a group of four dynamos. Of these four one is of higher E.M.F. than the others, and is used for starting the operation upon any one of the 18 separate crucibles which the switchboard is intended to control. At the top of the board are one double-break on and off switch for the high tension dynamo, to carry 500 ampères, and three 2-way switches each capable of carrying 1,000 ampères. Below these there are six "crucible" switches of special design constructed to "throw" a crucible from the high tension dynamo to one of the low tension ones, at the same time connecting the high tension dynamo to a resistance, and removing a resistance from the low tension dynamo, the object being to preserve the load upon the engine, gearing and dynamo approximately the same. The 18 lower switches are close contact 2-way switches, each controlling one crucible and allowing the current to each crucible to proceed to it either direct from its dynamo or by way of one of the above special switches. By this arrangement 18 or more crucibles can be controlled at a time by means of the special switches, each one of which manages three. Provision is also made for an addition either to the number of dynamos in use or to the number of crucibles operated by each dynamo. The switches, which are very substantial, are furnished throughout with Drake and Gorham's adjustable ring contacts, and all of them are double breaks.

Underground Electric Tramway for Paris.—The Third Commission of the Municipal Council of Paris has under consideration a project of an underground electric tramway to connect several of the chief points of this city. The project, due to M. Berlier, has been examined and reported on favourably by the engineers in the service of the municipal authorities. There are to be three lines running from the Place de la Concorde, one to the Bois de Boulogne, another to the Place de la Bastille by way of the great Boulevards, and the third to the Porte de Vincennes by way of the Rue de Rivoli. All these lines are to run underground for the whole distance. The tunnel, instead of being constructed of masonry in the usual way, will be formed of a cast iron tube of circular section and 6 m. in diam. It is proposed to construct these lines without opening the streets at any point. The tunnels, the stations, and the cars are to be lighted by electricity. One great advantage will be the good insulation which it is possible to maintain in an underground line of this character. The estimated cost for the whole length of a little more than 16 kilometres is £2,160,000, an average of £129,400 per kilometre.

A Compliment from Boston.—Our Boston contemporary has forwarded, with "compliments of *Modern Light and Heat*," a handy book of memorandum slips, to which is appended Simple Definitions and Formulæ for Unprofessional Readers, in a cover rather cleverly imitating Russia leather.

Exhibition at New Brighton.—An International Brewers', Vintners', and Industrial Exhibition is to be opened in the ensuing month at New Brighton, on the Mersey. The contract for the electric lighting of the buildings has been taken by Messrs. Hills and Thomson, Limited, of Liverpool. The scheme includes both arc and incandescence lighting, a special feature being the employment, amongst the latter, in the interior of the building, of a number of the "Sunbeam" high candle-power lamps. The manager of the company states that he has recently been using these lamps with good effect in ship lighting; and in the case of the Atlantic liner, *City of Rome*, all the arc lamps hitherto used in the engine-rooms and as cargo lights have been replaced by "Sunbeams."

Electrical Winding Ropes.—At the Newcastle Exhibition was shown a working model of an invention by Mr. Armstrong, of the Wingate Grange Colliery, Durham, by which a means of communication is afforded between the occupants of a colliery cage and those on the surface at any moment of its progress up or down the shaft. All that the inventor does is to have woven in the core of the winding rope, at the time of manufacture, an insulated wire. Vyle's easily tested lightning conductor, invented nearly ten years ago, is on precisely the same plan. Steel winding ropes, with the insulated wire enclosed, are manufactured by Messrs. D. H. and G. Haggie, of Sunderland, who are inclined to think that hawsers made on a similar plan would meet the requirements of telegraphic communication with lightships and lighthouses.

Personal.—Messrs. Stegmann and Engel have recently commenced business as electrical and mechanical engineers at 64, St. John's Road, Clapham Junction.

The partnership of Messrs. Saxby and Farmer expired on 31st March last, and Mr. Saxby's interest was then acquired by Mr. Farmer, who is continuing the business on the same lines and under the old style of Saxby and Farmer.

Bomb Fired by Lightning.—A letter from a special correspondent with the Italian forces in Abyssinia contains an account of an explosion of a bomb by lightning. The bomb consisted of a glass bottle charged with powder and scrap iron, fitted with a detonator to which a wire was attached. Several of these were scattered for purposes of defence in front of the battery of guns, the discharging wires being at the battery. It was found, so it is said, that lightning passing along the wire to one of the bombs had produced the explosion.

Artistic Use of Electric Light.—On the occasion of Mr. Hubert Herkomer giving a performance of his musical drama, *The Sorceress*, at Bushey, the stage of his small theatre was illuminated electrically. There were no footlights, the stage being lit by a "moon" made to travel along a kind of orbit. It is not related whether it "waxed and waned," but it is said to have had a very realistic appearance. The entertainment was a brilliant success.

Giving Him a Pull.—The *Financial News* states that the Earl of Crawford and Balcarres is more than a distinguished astronomer, and he has interests elsewhere than in the stars. He has got the House of Lords to read a second time a Bill which *inter alia* provides that within a given time all electric lighting companies must place their wires underground. This is a good stipulation in the public interest; but the beauty of the Earl of Crawford's advocacy of the provision is that the company in which he owns shares has the right to use the underground railways for laying its wires. Thus the inclusion of this clause in the Electric Lighting Bill gives Lord Crawford's company a pull over all possible rivals.

The Transmission of Power.—Mr. E. B. Ellington, M.Inst.C.E., who read a paper last Tuesday at the ordinary meeting of the Institution, on "The distribution of hydraulic power in London," states that the practical efficiency of the hydraulic system might be fixed at from 50 to 60 per cent. of the power developed at the central station, and he thinks that no other method of transmission would, to say the least, show a better result.

A Chairman's Error.—*Apropos* of the Maxim-Weston Company's meeting, Mr. Hugh Watt may yet have the opportunity of tendering for the proposed Bradford installation, as the time for delivery of tenders did not close yesterday as he stated it did. A reference to our pages of last week would have made Mr. Watt aware of the fact that an extension of time till May 1st had been granted.

The Telephone Union, Limited.—The immediate registration of this company with a nominal capital of £10,000,000 enables it to escape the prospective duty of £1 on every £1,000. What a nice little sum for the Exchequer £10,000 would have been to net at one fell swoop!

Electric Motive Power.—The electric motor has been very favourably received in St. Louis, Mo., as a substitute for steam power, especially among the manufacturing industries. It is now employed to the extent of 125 horse-power or more, as compared with 300 to 400 horse-power in daily operation in Boston, in connection with cash railways in stores, light sewing machines, ventilating fans, elevators and foundries. Boot and shoe manufacturers, tailors, and printers are, from the nature of their callings and surroundings, among its most promising prospective users. Already two shoe factories are driving their entire machinery with electricity, and there are upwards of 20 other establishments of the kind to look to for further sales of the motor. Some of the printing offices have also committed themselves to the use of the electric motor, and others may be reasonably expected to follow suit.

Electric Light and Power.—We hear that a freehold site has been secured for engines of 1,200 horse-power between St. James's Square and Jermyn Street, and that numerous promises of support have been received by the company formed for the purpose of lighting the district. The parish authorities were approached in the first instance and duly consulted, and this has led to the understanding that a sound undertaking will be welcomed provided the requirements of the parish are carefully though gradually attended to. The northern portion of St. James's parish consists of the densely inhabited district from Golden Square to Oxford Street. Here a multitude of hard working people live, whose machines worked by hand or foot can receive, according to the views of the promoters of the scheme, electric motive power from the engines of the company.

NEW COMPANIES REGISTERED.

Ashworth Brothers Company, Limited.—Capital £10,000, in £10 shares. Object: To adopt an agreement of 13th March between Thomas Ashworth and Fredk. King for acquiring a license of the patent, No. 4,081, and to carry on in Manchester and elsewhere the business of an electric light company in all branches. Signatories (with 1 share each): Thos. Ashworth, Higher Broughton, Manchester; Hy. Ashworth, Walsden; T. E. King, Lower Broughton; F. King, Salford; J. Whittaker, Higher Broughton; J. Suthers, Todmorden; C. E. Hodden, Royton. Registered 19th inst by J. F. Brier, Manchester.

Thorneburry Light Company, Limited.—Capital £20,000, in £5 shares. Objects: To purchase certain letters patent referred to in an agreement entered into with James Thorne, and to carry on the business of a light and lamp manufacturer in all branches, whether in connection with electricity, oil, gas, or other means. Also to supply heat and motive power, and to carry on business as electricians, mechanical and chemical engineers. Signatories (with 1 share each): James Thorne, 85, Gracechurch Street; R. J. Danter, 19, Bishop's Road, Brixton; J. W. Hammond, 7, Chester Road, Upton Park, E.; E. H. Parke, Stanley Terrace, Deptford Lower Road; V. Bass, 179, King's Road, N.W.; A. J. Birkworth, 9, Alderbrook Road, Balham; W. H. Urry, 37, Leonard Street, Finsbury. The signatories are to nominate the first directors. Qualification, 50 shares. Registered 19th inst. by J. and R. Gole, 4, Lime Street. Registered office, 85, Gracechurch Street.

Dalmatia Mining and Electric Power Company, Limited.—Capital £60,000, in £1 shares. Objects: To purchase the Dalmatia Mine, California, and to acquire

machinery of every description, including machinery for electric motive power, and to amalgamate with others having works, electric and otherwise. Signatories (with 1 share each): T. C. Kipling, 89, Englefield Road, N.; W. P. Owen, 91, Vassall Road, Brixton; J. H. Saunders, South Norwood; C. S. Clarke, Loughton, Essex; E. G. Appleby, Surbiton; A. J. Phelps, Upper Norwood; J. C. Price, Tooting. The first directors are W. G. Logan, Col. Baldwin, S. Jennings, Major W. Plumer Gaskell, and G. C. Pearson. Qualification: 250 shares. Remuneration, £105 per annum. Registered 20th inst. by K. R. Fletcher, 18, Finsbury Circus.

Telephone Union, Limited.—Capital £10,000,000 in 2,000,000 shares of £5 each. Object: To carry on the business of a telephone company in all branches, with power to acquire the business, property and undertaking of any other company formed for a similar purpose. Signatories (with 1 share each): J. Morris, Frank Crisp, 6, Old Jewry; James Brand, J. H. Brand, 65, New Broad Street; J. B. Morgan, Oxford Court, Cannon Street (managing director, United Telephone Company); S. Edwards, J.P., 24, Fenchurch Street; Dillwyn Parrish, 2, Copthall Buildings. Registered 23rd inst., without articles of association, by Ashurst, Morris and Crisp, 6, Old Jewry.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Midland Electric Light and Power Company, Limited.—The annual return of this company, made up to the 12th inst., was filed on the 20th inst. The nominal capital is £50,000, in £10 shares; 157 shares have been taken up, and 150 of these are considered as fully paid. Upon the remaining 7 shares the full amount has been paid.

An agreement dated the 19th inst. provides for the allotment to Mr. Arthur Chamberlain, of Birmingham, of 2,074 fully-paid shares in the company in satisfaction of £20,740, part of an amount of £20,747 9s. 8d. due to him by the company.

Telephone Company of Egypt, Limited.—The annual return of this company, made up to the 20th ult., was filed on the 19th inst. The nominal capital is £100,000, divided into 16,000 preferred and 4,000 deferred shares of £5 each. 12,071 preferred and the whole of the deferred shares have been allotted, and the full amount has been called thereupon. 12,000 preferred and 4,000 deferred shares are considered fully paid. The calls received amount to £355.

China and Japan Telephone Company, Limited.—The annual return of this company, made up to the 9th inst., was filed on the 19th inst. The nominal capital is £20,000 in £1 shares. 14,761 shares have been allotted, and these are considered as fully paid.

Railway Electrical Contractors, Limited.—The annual return, made up to the 19th inst., was filed on the same day. The nominal capital is £25,000 in £5 shares. 5,000 shares have been allotted, 3,750 being issued as fully paid, and 750 were issued as fully paid for £500 cash. Upon 500 shares the full amount has been called up, and the full amount is deemed to have been paid on 4,500 shares. The calls paid amount to £2,600 and unpaid to £400.

New Electric Light Syndicate, Limited.—At a meeting of this company, held at 139, Cannon Street, on the 21st ult., it was resolved:—"That the remuneration of each director be and is hereby fixed at the sum of £3 sterling for each attendance at the weekly meetings of the board on and after this date." This special resolution was confirmed on the 6th inst. and duly registered on the 19th inst.

Kensington and Knightsbridge Electric Lighting Company, Limited.—The registered office of this company is at the Kensington Court Electric Lighting Station, High Street, Kensington.

INCANDESCENT LAMP PATENTS.

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY *v.* HOLLAND AND OTHERS.

(*Before* Mr. JUSTICE KAY.)

THIS case, adjourned from the previous Thursday, occupied the Court for half-an-hour on Tuesday, when Sir HORACE DAVEY, Q.C., continued his opening speech for the defendants. He made brief quotations from several specifications of Lane-Fox which it was intended to rely upon as being anticipations of Edison's invention. The case followed another part-heard adjourned case which lasted throughout Monday and until one o'clock on Tuesday. His lordship was to sit in Chambers on Tuesday afternoon, so that at half-past one, when the Court rose for luncheon, the case was adjourned until Wednesday morning.

WEDNESDAY, APRIL 25TH.

Sir HORACE DAVEY resumed his opening this morning, stating the contents of the provisional specification of Lane-Fox, dated March 20th, 1879, for "improvements in the means or apparatus for obtaining light by electricity, and the manufacture of materials to be employed therein." This specification, counsel said, related entirely to the lamp, whereas the former ones, or the greater part of them, were devoted to the distribution of electricity with the view of lighting in series or in multiple arc. This last specification obviously described a vacuum. It might be, as Dr. Hopkinson said, that it was quite consistent with putting in nitrogen gas instead of having a complete vacuum; but it required a vacuum as far as gases of a deleterious character were concerned. Mr. Lane-Fox's apparatus was a lamp exhausted of oxygen or other destructive gases; light was to be given by what he called a luminous bridge of conducting material placed between two fine wires, which were to be hermetically sealed within the lamp. He proposed to make his luminous bridge—he (Sir Horace) was not at all concerned to say that it was a good way, for he believed it was not—in very much the same way that Edison proposed to make one of his burners, that which was to be composed of putty and tar; in fact, there was a curious similarity in the language employed in the two specifications. Mr. Lane-Fox's specification clearly enunciated the principle that the material for the luminous bridge must have a high specific resistance, and an actual resistance of 300 ohms; in other words, he recognised the principle that in order to get a good, economical incandescent lamp for the purpose for which he wanted it, lighting by multiple arc, it was necessary to have a burner of high resistance. It was unfortunate, perhaps, as matters turned out, that Mr. Lane-Fox was concerned chiefly with the production of a lamp which would be suitable for a particular purpose, while the more fortunate inventor was working at the same time upon the construction of the lamp itself. Having referred to the lamps made and used for practical purposes by Mr. Swan and Mr. Stearn, Sir Horace submitted that Edison's specification of November, 1879, added nothing to the stock of knowledge in the world at that date, and that it was void, on account of insufficiency of specification. The workman of 1879 could not have made a serviceable filament by following the directions contained in Mr. Edison's patent.

Mr. JUSTICE KAY asked if Sir Horace Davey would admit that, supposing that it was not disputed that Edison was the inventor of an incandescent electric lamp with a carbon filament, and that he described one practical mode of making the filament, he was entitled to prevent anybody else from making a carbon filament in any way whatever.

Sir HORACE DAVEY replied that he should deny that proposition. If the patentee described several modes, and only one was practical, it had been held that the specification was misleading, because it imposed upon anybody attempting to carry out his invention a burden which a patentee had no right to impose, that was the solving of problems and the making of experiments.

Mr. JUSTICE KAY said that was not quite the point he had wished to put. Supposing but one mode were described, and that one mode was a perfectly practicable one, could the patentee then prevent anybody else from making carbon filaments in any other mode whatever?

Sir HORACE DAVEY replied that granting that the patentee discovered and stated a new principle, if he described one practicable mode of carrying that principle into effect, he was entitled to protection as against all other modes of producing the same thing. But here Edison did not disclose a new principle, and moreover he described modes which were not practicable. He then proceeded to criticise Edison's specification, asserting that it was vague in terms and insufficient. He said that Edison deliberately abstained from defining what he meant for the best of all possible reasons, namely, because he had not worked it out in his own mind; he had conceived what he believed to be a new idea, but what was not in fact a new idea, and he immediately took out his patent without waiting to work out the idea in such a definite practical shape as the law required of a patentee when he described his invention. Whilst counsel was upon the question of the filament,

Mr. JUSTICE KAY asked whether the word filament was altogether independent of length.

Sir HORACE DAVEY: I am afraid to say, my lord. I have several definitions here.

Mr. JUSTICE KAY: Suppose the thickest cable ever made were

of sufficient length to stretch from here to the moon, would that be a filament?

Sir HORACE DAVEY: I do not know. The nearest approach to a a definition arrived at by the united efforts of my friends, Mr Aston and the Attorney-General, was that a filament was something of a filamentary character. I think Mr. Aston suggested as an alternative that it was something of a filamentous character.

Mr. JUSTICE KAY: "Fil" means thread.

Sir HORACE DAVEY: Yes. And the word has a definite meaning in botany, where portion of the stamen is termed a filament irrespective of length, and as a matter of fact it is sometimes of considerable size. But what the meaning of the word filament was in November, 1879, or what the word means as used by Edison, is a matter of extreme doubt, and one of my submissions to your lordship is that Edison has described what he meant in studiously vague language; has given those who make lamps no warning; has not fenced his invention with sufficiently definite language as to what he really meant by the word filament. Surely a man must not describe his so-called invention in such studiously vague language, such uncertain, indefinite language, as to leave a person of such high scientific and practical attainments as we all know Dr. Hopkinson to be, in doubt as to where the fence is which guards the invention. Dr Hopkinson even thought the conductor in one lamp which was put forward as admittedly made under Edison's specification was not a filament. The question having arisen, Sir Horace Davey said the difference between the last trial and this was that in the Woodhouse and Rawson case the defendants seemed to have relied principally upon Swan's and Lane-Fox's anticipations, and the only form of serious anticipation before the Court was the lamp of Mr. Swan which was used at lectures, and which contained the burner of $\frac{1}{25}$th inch diameter. There was no evidence whatever given for the purpose of raising the question, or of showing the Court, even assuming that the specification meant a combination of any kind of carbon filament, however made, with the other elements stated, that it did not contain sufficient direction to enable a carbon filament to be made. The parties apparently thought they had a sufficiently good case upon the anticipation, and they did not give any evidence of experiments showing the insufficiency of the specification. In this case experiments had been made, and he was prepared to show his lordship that the specification did not contain any description or directions whatever from which the Court could form an opinion or judgment as to what Mr. Edison intended to include under the term "carbon filament." Sir Horace proceeded to enlarge upon the evidence of Mr. Gimingham as to the manufacture of lamps under Edison's specification. Even he, with the advantage of special training in science schools and in his brother's laboratory, could not produce a filament without first making experiments; it was two or three days before he found out the way—the best way, he said—to make his first lamp. The lamps made by this witness were the only practical lamps ever produced which were Edison lamps pure and simple, according to the specification of November, 1879; and one of these lamps was of such low resistance as 5½ ohms, although it was claimed that high resistance was one of the essential conditions of an Edison filament. The plaintiffs spoke of "world-wide Edison lamps," but, as a matter of fact, no one had ever seen a practical commercial lamp made under Edison's first specification. No one saw in this country, or in Europe, an Edison lamp of any kind until years after, at the Paris Exhibition of 1882. With regard to the subsequent patents of Mr. Edison, describing methods of carbonising filaments, it was said by the plaintiffs that they were merely for details. His (Sir Horace's) contention was that those details were what made all the difference between success and failure. It was evident that Mr. Edison himself did not consider that his first specification disclosed a sufficient method of carbonising, for he showed that he considered himself entitled to a separate patent for descriptions of methods of carbonisation. With regard to Cheesbrough's patent, the defendants placed the chief reliance upon the papers of Despretz and Sidot. It was true that Sidot carried out the process by means of external heat instead of by passing an electric current through the carbon itself, but the process was practically the same as far as the application of heat was concerned. The material described by Despretz as a phenomenon which he had encountered in the course of his experiments was precisely identical with the material for which Cheesbrough claimed a monopoly.

Mr. JUSTICE KAY: Neither Sidot nor Despretz had the same end in view as Cheesbrough?

Sir HORACE DAVEY: No, my lord, that is so. That point was before the Court of Appeal in the other suit, but those who were responsible for the defendants' case at that time for some reason had relied upon the cross-examination of the plaintiffs' witnesses, and did not call evidence of their own. He should, however, call evidence which would show beyond all cavil that the material which presented itself as a disagreeable phenomenon to Despretz was identical with the material described by Cheesbrough. Another point which was not raised in the other case was as to the utility of Cheesbrough's alternative process in one particular. Cheesbrough claimed first a method of producing a material, and secondly the material itself as such. He did not claim an application of an old material to a new purpose, which might be subject matter for a patent, if there was sufficient novelty or invention in the application.

Mr. JUSTICE KAY: Would such a claim prevent anybody else from making the material for any other purpose?

Sir HORACE DAVEY thought it would. But if he claimed that, the plaintiffs must show that there was sufficient novelty in the application. But there was no novelty claimed or described by Cheesbrough; he did not describe or claim a mode of application. The only mode described by him was the mode in which he made the material and he left the person who used the invention to apply for himself. Concluding his argument, Sir Horace said his clients had expended very large sums of money upon bringing their manufacture of lamps to a considerable amount of perfection, and their very success depended upon the trials and experiments which they had made, and which had enabled them to surmount the difficulties and supply the deficiencies which Edison in his patent left wholly unsurmounted and unsupplied—perhaps because he was not aware of them.

Mr. ROBERT PERCY SELLON was then called, and examined by Mr. FINLAY, Q.C. He said he was chief electrician to the Anglo-American Brush Electric Light Corporation, and had been engaged upon electrical work for the past eight years. He was quite familiar with the process adopted by the Brush Corporation in the manufacture of lamps. The material which they took for the manufacture of the carbon for incandescent lamps was cellulose in an exceedingly pure condition. It was formed by dissolving ordinary cotton wool in a solution of chloride of zinc. By the application of slight heat this produced a viscous semi-liquid mass. That material was then forced through a die or small orifice, and was allowed to pass into alcohol. The effect of the alcohol was to precipitate the liquid emerging from the die in the form of an endless thread. It was forced through the orifice by pressure applied in any convenient way; as a matter of fact, it was applied by a head of mercury. Air bubbles were removed by the boiling of the viscous mass before forcing through the die, the vessel containing it being in connection with an air pump. The effect of the alcohol was not only to stiffen the thread but to withdraw the metallic source, the zinc chloride, and other impurities. It was afterwards steeped in another jar of alcohol. The result was a non-structural thread of cellulose in an exceedingly pure condition. The thread while still wet was wound upon wooden drums, which were covered upon the surface with velvet. A considerable amount of contraction took place during the drying, and there was sufficient "give" in the velvet to prevent fracture of the material while drying. The next stage was to wind that material upon a block of plumbago with a piece of cardboard in it. The thread was retained in position by a piece of cotton being wound round it. The thread as it was carbonised contracted considerably, and the cardboard was consumed away. The blocks having the thread wound upon them were packed one upon another in a crucible filled with powdered plumbago. A little paraffine wax was placed on the bottom of the crucible: this, by melting at an early stage of the carbonisation, drove off any deleterious gases in the interstices of the plumbago. The crucible was closed and placed in a furnace. Heat was applied gradually, it taking half-a-dozen hours to produce a white heat temperature. The object of gradually applying the temperature was that the volatile matters in the carbonisable material should not be driven off too rapidly and cause deterioration in the material. At the end of the six hours of gradual heating the temperature was raised to the most intense heat the furnace would give, which was probably about 3,000° Fah. The total period during which the material was left in the furnace was eleven hours. The crucible was then taken out, allowed to cool, and the plumbago blocks with the carbonised thread upon them withdrawn. The thread was next mounted upon temporary metallic clips and subjected to the process of electrical heating in a hydro-carbon atmosphere. Current was passed for a few seconds only, the object being to obtain relative uniformity of resistance between carbon and carbon; the resistance was measured by an ordinary Wheatstone bridge. The current was allowed to pass intermittently, and the resistance tests taken between the periods of application while the burner was cold; if the resistance was not satisfactory the current was again applied, and the process was repeated until the desired point was reached. The amount of deposit required to produce the required uniformity was very small, about 5 or 10 per cent. of the total bulk of the thread only. The next step was to "mount" the burner upon its platinum wires. It was inserted in platinum supports twisted into a small spiral at the end. Then one end of the flashed filament was placed into the spiral, where there was temporarily sufficient friction to hold the two together while the points of junction were subjected to electrical heating in a hydro-carbon atmosphere. The current, by means of a special mechanical device, was prevented from passing into the body of the burner, so that the heat was applied only to the points of junction. The end of the filament was inserted into the spiral to the length of about one-eighth of an inch.

Specimens of the materials referred to by the witness were put in. At this stage the Court adjourned for the day.

THURSDAY, APRIL 26TH.

Mr. R. P. SELLON, continuing his evidence, to the examination of Mr. Finlay, said: After the processs of mounting the next step is to seal the carbon thread with the wires in the glass globe. That is done by means of a blowpipe in the ordinary way. The next stage is to exhaust the globe. The exhaustion is first carried out without the current, then for a short time with the current passing through the carbon. The globe is also heated outside for the purpose of drying the inner surface of the glass and to expand the air. That is the process known as "running on the pumps." That completes the process. [Complete lamp put in.] I am familiar with Edison's specification, and have carefully

studied the process therein described. I have made a considerable number of attempts to carry out that process. I think the instructions in the patent with regard to the manufacture of incandescent lamps are quite insufficient to enable a workman to make a practical useful lamp. I have tried all the processes described by Edison, except as regards the winding of the carbon upon the copper helix, described on page 4, lines 42–46. [Specimens of attempts produced.] As regards the suggestion towards carbonising described by Edison, I don't think a workman would have known in November, 1879, that it would be necessary to pack the crucible with material to prevent the destruction of the carbon burner. The carbonisation of wood charcoal was known, and also carbonisation in connection with gunpowder manufacture, and, finally, there was some knowledge in reference to the carbonisation of rods or pencils for arc lighting. But carbonisation which would have answered admirably for all these purposes would not have been sufficient for the purposes of very slender carbons such as are used in incandescent lamps. In the three cases of carbonisation mentioned as known before 1879, for example, the certain amount of the wasting away of material undergoing carbonisation and the roughening of the surface would not be a matter of great inconvenience. But where you are dealing with these carbons for incandescent lamps, the most rigid exclusion of air is essential. As instancing what the knowledge was before 1879, in the carbonisation of arc lamp carbons, sand had been used within the crucible, not as the sole packing, but had been included with other things. Packing the crucible with sand for carbonising incandescent lamp burners would result in the destruction of the carbons. In attempting to make lamps in accordance with Edison's instructions, I packed the crucible with plumbago, knowing that in the absence of that there would be total destruction of the material. I produce some samples of cotton threads, smeared with lampblack and tar, and some of paper and of wood splints, carbonised under those circumstances. The result so far as the process of carbonisation is concerned, has invariably been this, that all the materials mentioned have come out of the carbonising process extremely fragile and roughened, and it was practically impossible to manipulate them. In the examples there are two distinct groups, one composed of filaments made from fibrous vegetable substances, such as cotton thread, wood splints, and so on, the other of the lampblack and tar putty order. I selected boxwood for the wood splints, because I thought that would be likely to succeed where other kinds of wood might fail. There is little resinous matter, comparatively, in boxwood. These filaments were carbonised at a temperature just below that of melting copper. I infer that that is the heat Edison desired, because he says he winds the cotton thread on a copper helix, and afterwards eats the copper away by means of acids. The melting point of copper is, I believe, about 2,200° Fah. In every case the junction with the platinum wires was made by moulding the plastic lampblack-tar material around the joint as Edison describes. In no case was I able to get a result of practical utility. There are several elements of failure in the processes which he describes. Firstly there is the process of carbonisation. Apart from the matter of packing with carbon, it is necessary for the production of carbon filaments of any practical value whatsoever to place them upon moulds or under some pressure which enables them to retain their form, and which at the same time will permit of the considerable amount of contraction which these vegetable materials undergo during carbonisation. I can find nothing directing that in Edison's specification, and I do not see how any ordinary workman could have known it in 1879, having regard to the fact that the carbonisation of such very slender materials was then quite unknown. When I say unknown, it was not common knowledge. There were no doubt several workers who had been engaged upon these matters, among them Mr. Lane-Fox, Mr. Swan, and M. Carré. Another cause of failure is common to all the processes, and that is that when the platinum wire which is used with the threads undergoes carbonisation an alloy of platinum is formed; there is chemical action set up between the carbon and the platinum after mounting and carbide of platinum is produced. The effect of this is that the platinum is rendered very porous and spongy and rough in character—the whole of the platinum in the crucible. The platinum is rendered very brittle, and it becomes very difficult to seal it into the glass globe; but even assuming that you succeed in the sealing, it is very difficult, even if it is at all possible, to obtain a vacuum. [Specimen put in and included in exhibits.] We tried with the Sprengel pump with that lamp sufficiently long to convince ourselves that it was impossible to obtain a vacuum. These two causes of failure are common to all the specimens I produce. Taking the wood splint filaments, beyond that the carbons are extremely fragile and roughened, there is nothing peculiar to that group. In the next group, the cotton thread and the paper, there is this element of failure which would certainly stand in the way of enabling a practical filament to be made. Vegetable substances contain a great many impurities, such as silica and so on. Unless some precautions are taken to free the material as far as possible from these impurities, such as by parchmentising, there is no doubt a chemical action set up in carbonising between these impurities and the material to be carbonised. This results in their being obtained from the furnace extremely fragile and porous or cross-grained in character, and the inevitable result of this must be that when the current is passed through it it will become heated unevenly, exhibiting bright spots. In addition to this, it would be virtually impossible to get incandescent lamps made of such materials to run together, that is to say, to give a similar degree of illumination when run from a similar source of power. I feel sure that this difficulty is a very real one, from the fact that, so far as I am aware, and I believe I know the process observed in the production of all the best known types of lamps, no practical lamp has been made, or ever placed upon the market, in which some such process as that of parchmentising has not been adopted. We do not parchmentise our carbons, because they are not made from fibrous vegetable substances, and do not contain silica or similar impurities. There are chloride of zinc salts produced, and an analogous process to that of parchmentising is resorted to. In the remarks I have just been making I have been referring to lamps made of cotton thread and paper. I am well aware that in the Edison bamboo lamp no such process is observed, the bamboo being used direct. Referring now to the instances of cotton thread rubbed with the compound of lampblack and tar, Edison's suggestion is that you may make your resistance high or low, according to the amount of the compound placed upon it. This strikes me as not being a practical process, because I think Edison is preparing the resistance by smearing it before carbonisation, and I think that by that suggestion he may have intended to meet the desideratum that lamps should run at an even luminosity. I think it would be absolutely impossible by following out this process of smearing with putty before carbonisation to obtain results such as I understand Edison desired, to any practical or useful extent. I have no specimens of filaments composed entirely of lampblack and tar alone, but have made a great many experiments with the view of testing the practicability of that process. I tried to follow his directions by "igniting lampblack in a closed crucible for several hours." I afterwards moistened the lampblack with tar, and kneaded the whole until it became a thick putty. I endeavoured to roll up pieces of this material in the form of a wire $\frac{1}{1000}$th inch in diameter, as mentioned by Edison, but failed. The nearest I approached to that was a diameter of 1 mm., or $\frac{40}{1000}$ths of an inch. I first endeavoured to form this into a spiral, taking Edison's drawing, fig. 1, as a guide. Obviously for the purposes of Edison's spiral, the diameter of the coils must be small, and the convolutions close together. All my attempts to obtain a spiral in this form, however, failed, owing to the fact that when the putty was rolled down to a small diameter, it cracked all through and broke; that is to say, it became covered with small cracks. I then formed this material into the shape of a horseshoe, in order to surmount the difficulty of cracking. I joined it to platinum wires by means of the putty material moulded round the joints, and carbonised it under the conditions as regards temperature described by Edison. The result in every case was that the horseshoes were obtained in an extremely friable condition, so that in many cases they would break upon being merely lifted from the crucible. But in every case if you succeeded in obtaining them from the crucible they were so extremely fragile that the amount of manipulation they would have to undergo would almost inevitably fracture them. In my opinion it is not possible to make a workable filament of lampblack and tar. I have tried to make filaments other than those of the putty material into the form of a spiral. I have tried rolling a thread in the putty, but the result was substantially the same as where the putty alone was experimented with. The latter form was less liable to crack than the other, but the putty material upon the thread did crack. I have prepared a lamp containing a cotton thread filament according to Edison's specification. The thread in this was not smeared with putty; it was not parchmentised; I gave it the benefit of powdered plumbago in the crucible. I wish to explain that the process of mounting has not been carried out according to Edison's instructions; it is merely his process of carbonisation. The burner is evidently of a porous and rough character, and is wanting in stability to an extent which would render it useless for practical purposes. I have tried the use of camphor and oxide of zinc as suggested on p. 4, line 14, of Edison's specification. The result was that when the current was passed through the lamp the oxide of zinc and camphor combined with the carbon, producing carbonic acid; the metallic base was reduced and volatilised, and the surface of the globe obscured. The resultant carbon was extremely porous and open-grained, and such carbon would very soon disintegrate when put into operation. I would explain that this occurred when the percentage of volatile powders was small relatively to the carbon. In cases where the percentage of volatile powders had been large relatively to the carbon, the carbon was destroyed at once. For practical purposes no one would ever dream of using such a carbon. I have been familiar with incandescent lamps in use since 1880. There have been no lamps in use, so far as I am aware, under Edison's patent of November, 1879. I am aware of what had been done by Mr. Swan from reading what has been published. I have made lamps similar to that of Mr. Swan which has been put in containing the straight carbon pencil $\frac{1}{25}$th of an inch in diameter. I have tried their working for a considerable number of hours. I find that they work perfectly satisfactorily as individual lamps. Such lamps, being of low resistance, would not be suitable for distribution where a number of lamps are required at great distances from the source of generation. These lamps I made in accordance with the description of Mr. Swan, given either at a lecture or before the Literary and Philosophical Society of Newcastle. With reference to Cheesbrough's specification we use the process of flashing, but not for the purposes described by Cheesbrough. I am prepared to show our carbon filaments both before and after carbonisation under a microscope. Broadly speaking, our filament does not require the deposit: it is so dense throughout its length that we have made lamps without flashing at all. There are no inherent defects in the carbons themselves which would require to be corrected by this process. The primary object with

which we carry out this process is to obtain uniform resistance. It is quite possible that a burner might be obtained from the carbonising process which would be injured, and would be uneven in its lighting power. In such a case the process of electrical heating in a hydro-carbon gas would cure that defect; but that is quite an exceptional occurrence. There is a reference in Cheesbrough's specification to a temperature of 7,000° Fah.; the effect of such a heat upon a carbon would be total destruction. Carbon volatilises in the electric arc, and the heat of the arc has been calculated to be something over 5,000° Fah.; therefore a temperature so much greater would certainly cause immediate destruction. The resistance cold of the lamp I made in imitation of Swan's stick-carbon lamp was between 1 and 2 ohms. I have tried the resistance of the lamps put in by the plaintiffs as made under Edison's specification, and the average is 2½ ohms. I have not the exact results by me, but that is my recollection. That is the resistance cold.

Mr. ASTON, prior to commencing his cross-examination, said a great amount of Mr. Sellon's evidence with reference to experimental lamps was new to the plaintiffs, and asked that he might reserve any questions about it until they had had an opportunity of considering what the statements made amounted to.

Mr. JUSTICE KAY dissented from this course, and said that if it were pursued with every witness the case would be indefinitely prolonged.

Cross-examined by Mr. ASTON: I understand you to say that you were not familiar with the manufacture of pieces of carbon, to be used for electric lighting, in a closed retort with charcoal?—I did not mean to imply that I was not familiar with the carbonisation of carbon under conditions where charcoal was used.

But I am now speaking of 1879?—I was not then aware of it.

You were not aware that electrodes were manufactured by taking pieces of carbon and carbonising them in closed retorts?—Not at that time.

I suppose that you have read the alleged anticipations?—I have.

You remember Staite's specification, and that he says that "electrodes are made by being gradually exposed to the strongest white-heat of a furnace for some days in closed vessels with charcoal"?—I remember the passage.

Mr. JUSTICE KAY: How would that teach the workman to carbonise threads in a powder?

Mr. ASTON: I should of course submit in the same way.

Mr. JUSTICE KAY: That is, to carbonise pieces of charcoal in which there might be any amount of air. There is nothing about powder. Besides, in a mass of that size it would not matter if it did waste a little.

Mr. ASTON: In the specification there is indicated the packing of the electrodes in a closed vessel, with charcoal?—No doubt.

Mr. JUSTICE KAY: But there is no reference to the extra-ordinary exclusion of air there. On the contrary, it is said it may be surrounded by pieces of charcoal.

Mr. ASTON: But it is coated with melted sugar.

Mr. JUSTICE KAY: That would not exclude air from the crucible.

Mr. ASTON: But it would exclude air from the carbon. [To witness]: Would not the coating of sugar put on the electrodes have the effect of protecting them from the operation of whatever amount of air might be included between the pieces of charcoal?—Surely that would depend upon the amount of air in the interstices.

Supposing them closely packed?—Where you have pieces of charcoal there would be unavoidably a very large amount of air present. Coating with sugar might protect it for some period, but in carbonisation the coating of sugar would be consumed, and the carbon itself would then be attacked.

At all events, it is packed there with pieces of charcoal?—Yes.

But does it not say in one place, not "pieces" of charcoal, but simply "with charcoal"?—Yes.

In the description of Carré's carbon there is described what is called the "cooking" of carbon?—Carbon for arc lamps.

Paste is passed through a draw plate. The carbon is then placed in tiers in crucibles, and subjected for a given time to a high temperature. The "cooking" comprehends a series of operations. For the first, the pencils or carbon wires, if they were carbon wires, are operated upon.—It would be a carbon for arc lamps.

Mr. JUSTICE KAY: But they are packed in sand in the second operation there, and there is only a centimetre of coke-sand put above them in the first place. Is there no description here of the size of those carbons?

Mr. ASTON: Rods of 0·1 metre in diameter are mentioned.

Mr. JUSTICE KAY: Supposing the ordinary workman had read this, he would know that a rod of about ⅛rd of an inch in diameter would be treated in this way?

Mr. ASTON: Yes; then what conclusion a man might draw with regard to smaller sizes——

Mr. JUSTICE KAY: That would be matter of argument.

Mr. ASTON: That would be matter of argument, my lord. In another part carbons of 44 millimetres are mentioned.

Mr. JUSTICE KAY: From the evidence before me I should suppose that this process would never do for a thread. These carbons are placed horizontally on a bed of coke dust, every layer separated, and a covering of paper between the last layer and the cover. There is rather more than ⅛rd of an inch of coke-sand, and some amount of silicious sand, on the joint of the cover. There must be a quantity of air in that.

Mr. ASTON: Not, I should submit, with the coke sand, that is to say, pulverised coke.

Mr. JUSTICE KAY: Between the things laid down the interstices would not be filled up at all. According to the evidence at present before me I should infer that that would never do to make a carbonised thread.

Mr. ASTON: I shall, of course, give you the evidence of my witnesses upon what would be the effect of the heat being applied under these circumstances. I submit that so long as the particles of carbon——

Mr. JUSTICE KAY: I would rather you did not argue now.

Mr. ASTON: Very well, my lord. [To witness]: Would not carbon be given off from the heated carbonaceous matter, both from the electrodes and the coke surrounding it?—No doubt a small amount of coal gas would issue from the electrodes.

And would not that expel the air?—Certainly not sufficiently.

I did not say sufficiently; but the effect of that would be to take the place of air in the interstices?—No doubt.

Have you gone through Carré's descriptions to see what are the smallest sizes used there?—Carré says 44 millimetres.

Mr. JUSTICE KAY: Am I to assume that the ordinary workman knew all this? That can be its only utility.

Mr. ASTON: Of course ordinary workmen there were none at that time with special reference to incandescent lamps.

Mr. JUSTICE KAY: Then the ordinary workman would not know.

Mr. ASTON: But your lordship would see what knowledge the persons who were called upon to manufacture found ready for their use. Have you [witness] read the publications which are referred to in the notices of objection describing Carré's and Gauduin's processes of preparing carbons?—I have.

Is it not a fact that in those descriptions you find reference to the use of packing by means of carbonaceous matter and the application of heat?—No doubt.

Carré speaks there, does he not, of carbonising wood, reducing it to powder, agglomerating it and converting it into a hard carbon?—I think he does.

Mr. JUSTICE KAY: Surely that is hardly a proper question for a witness. The thing speaks for itself.

(*To be continued.*)

[The cross-examination of Mr. Sellon was concluded on Thursday afternoon, and Prof. Crookes, F.R.S., called to give evidence of experiments he had made in endeavouring to give effect to Edison's specification. His examination-in-chief had not been terminated when the Court rose at 4 o'clock, the further hearing of the case being then adjourned to Monday next.]

CITY NOTES, REPORTS, MEETINGS, &c.

The Western and Brazilian Telegraph Company, Limited.

THE fifteenth ordinary general meeting of this company was held at Winchester House, Old Broad Street, yesterday (Thursday).

The report of the directors adopted by the meeting stated that the total earnings amount to £159,789 11s. 1d., an increase of £21,123 10s. 3d. compared with the twelve months to 31st December, 1886. The working expenses for the year, exclusive of renewals of cable, amount to £64,315 19s. 5d., as against £62,604 0s. 1d., an increase of £1,711 19s. 4d.

Including the amount brought forward from 1886, the balance to the credit of the revenue account is £100,032 1s. 1d., from which has to be deducted £27,000 for debenture interest, leaving £73,032 1s. 1d., of which £15,000 has been placed to the renewal fund, and £10,000 to a debenture redemption fund, as explained further on. This leaves £48,032 1s. 1d. The directors recommend the payment of a dividend of 3 per cent. free of income tax, which, with the interim dividend of 1½ per cent. paid on 15th October last, makes a total dividend of 4½ per cent., leaving £3,464 8s. 7d. to be carried forward. This will give to the preferred ordinary shares £5 per cent. for the year, will clear off 3s. 1½d., the amount in arrear upon these shares, and will give 2s. 1½d. per share to the deferred ordinary shares.

In accordance with the terms upon which the company's debentures were issued, they are redeemable by annual drawings. The first payment, amounting to £11,200, becomes due in February, 1890, and the directors have thought it prudent to provide a fund for paying off the drawn bonds, in order to guard against fluctuations of revenue, and equalise the charges as nearly as may be from year to year. The provision made will not exceed an amount covering two years' drawings.

The directors propose to strengthen certain sections of the company's line by laying loop cables, and have communicated with the Government of Brazil with respect to landing points and facilities for the purpose.

The undertakings of this company and of the London Platino-Brazilian Telegraph Company, Limited, are so closely allied that it has become desirable in the opinion of the board, upon grounds of efficiency, economy, and the general advantage of both companies, that so far as may be practicable, without effecting an actual amalgamation of the companies—as to which at present difficulties stand in the way—they should be brought under a

common control, with a common proprietary, and, after long negotiations, arrangements have been made for this purpose. An agreement has been entered into by the board of each company for the exchange by the shareholders of the Platino Company of their shares for shares of this company at the rate of five shares of £10 of the Platino Company for three shares of £15 of this company, and for the substitution of directors and officers of this company for those of the Platino Company, who will receive compensation as provided by the agreement. The capital which may be required for these purposes will not exceed 24,000 shares. The agreement is subject to confirmation by special resolutions of each company, and is conditional upon three-fourths at least of the shareholders of the Platino Company exchanging their shares within fourteen days after such confirmation, or such extended period as may be agreed on.

This agreement will be submitted for approval to the extraordinary general meeting, and, if approved, a further resolution will be proposed, authorising the increase of the capital to £1,500,000 for the purpose of enabling its fulfilment and for the other purposes of the company. Both resolutions, if passed, will be submitted to a subsequent extraordinary general meeting for confirmation.

The directors recommend certain alterations in the articles of association of the company; to this end the meeting will be made special, after the ordinary meeting has been held. The notice convening the meeting shows the alterations proposed. The clauses in question formed part of the original articles of association of the company.

The directors regret to report the retirement of the chairman, the Right Honourable Sir Henry Drummond Wolff, G.C.M.G., K.C.B., on his appointment as Her Majesty's Minister to the Court of Persia. The seat thus vacated has been filled by the election of Lord Richard Howe Browne; and the directors have much pleasure in stating that Mr. Andrews has accepted the office of chairman.

At the conclusion of the ordinary general meeting an extraordinary general meeting of the company was held for the purpose of considering, and, if thought fit, passing the subjoined resolutions intended to modify the Articles of Association of the company, and to carry into effect the proposed arrangement with the London Platino-Brazilian Telegraph Company, Limited, referred to in the report:—

1. That the sixth and seventh Articles of Association, and so much of the 26th Article of Association as includes and follows the words, "but notwithstanding any rule of law or equity to the contrary" shall be cancelled.

2. That Article 50 shall be modified by the insertion, after the word "yearly" of the words, "and may be then half-yearly."

3. That the agreement, dated April 18th, 1888, between the Western and Brazilian Telegraph Company, Limited, of the one part, and the London Platino-Brazilian Telegraph Company, Limited, of the other part, be, and the same is hereby approved and confirmed, and the board are authorised to carry the same into effect.

4. That, for the purpose of the said agreement, and other the purposes of the company, the capital of the company shall be increased to £1,500,000 by the creation of 30,090 shares of £15 each, to rank *pari passu* with the existing ordinary shares of the company.

5. The directors may issue the shares required, for the purposes and on the terms of the said agreement. The residue of the said shares may be issued by the directors at such times, in such manner, and upon such terms as they determine.

The Maxim-Weston Electric Light Company, Limited.

An ordinary general meeting of this company was held at Cannon Street Hotel on April 18th, Mr. Hugh Watt, M.P., chairman of the company presiding.

The Secretary read the notice convening the meeting.

Mr. Klenck read the report of the committee appointed on March 28th to enquire into the position of the company, which was as follows:—"1. The committee have now to report that on going into the affairs of the company much of their time was wasted by the obstacles put in their way when they desired access to books and documents, and they have specially to report that up to the present time they have been unable to obtain an inspection of the minute book of the company. 2. The committee regret to inform the shareholders that the profit shown in the balance sheet submitted to the last meeting was misleading, and was only arrived at by the omission to make any allowance for bad or doubtful debts, and by unwarrantably writing up an increased value in the stock and patents of the company as compared with the valuations given in the balance sheet for 1886. The committee further state that the item in the balance sheet for December, 1887, of 'debtors £15,001 12s. 6d.' includes some old and some disputed accounts, the recovery of which appears to be doubtful. 3. The committee report that Mr. Louis Swabey is still a director of the company, and that he has held, and still holds, the necessary qualifications to retain his seat at the board. 4. The election of Mr. George Howell, M.P., as a director of the company was irregular, as there has not been a properly constituted board, at which he could have been elected pursuant to Clause 77 of the company's articles of association, since the 16th ultimo, when he became a registered holder of 250 shares of the company. 5. The committee are strongly of opinion that under the present circumstances of the company it is most important that the directorate should be forthwith strengthened by the addition of three, or more, independent gentlemen of resolute character and commercial experience to represent the interests of the shareholders of the Maxim-Weston Electric Company. (6.) The committee approach the grave question relating to the Watt dynamo machines and the Watt arc and incandescent lamps with considerable hesitation, as they are informed by Mr. Watt that these patents are not the property of your company, but belong to himself and others. The committee consider that steps should immediately be taken to secure the same for the company, as they find that the energies of the officials and workmen have been mainly directed, and the plant, machinery and premises of the company have been and are now almost exclusively used to develop and perfect the Watt patents, and considerable amounts of the company's money have been expended upon them. Moreover, your committee maintain that Mr. Watt's personal interest in the Watt patents can only be held in trust by him for the benefit of the shareholders of the Maxim-Weston Electric Company, Limited. (7.) In concluding their report the committee venture to express their opinion that the business of the company could be efficiently carried on at a much reduced cost. (Signed) J. M Klenck (Chairman), Henry A. Greig, Geo. H. Hilyard, Jno. Marks, John Newton."

Mr. Klenck said that he and each member of the committee would claim his right to reply to any remarks the chairman might make upon the report. The appointment of that committee was due solely to the determined manner in which Mr. Swabey had moved the rejection of the balance sheet in order that some investigation of the affairs of the company might take place, and Mr. Dever, the auditor, had specially drawn attention to the position of the company by the qualifying letter with which he had audited the accounts. He then proceeded to compare in detail the facts presented to the shareholders in the 1886 and 1887 balance sheets. In 1866 patents were valued as £38,229 17s. 1d., but in 1887 the value was written up to £40,737 1s. 1d. The stock of machinery, lamps, &c., at the factory in 1886 was set down as £13,440, whereas in 1887 the value was represented at £19,817, and the total value of stock and patents which in 1886 was £54,640, amounted as shown in 1887 to £64,158. He then proceeded to amplify in detail the paragraphs of the report, and moved the adoption of the report.

Mr. Hilyard seconded the motion for the adoption of the report, and stated that the business done by the company during 1887 was——

The Chairman objected that statements given in confidence to the committee should not be publicly announced. [A Shareholder: There is no confidence.] He held a vast amount of shares in the company, perhaps of much more value than those who did not mind the publication.

Mr. Hilyard proceeded, with all due deference to the chairman, and added that his interest, direct and indirect, represented 3,000 shares. The trade done in 1887 was £7,500.

The Chairman: I may state that the constitution of the board is quite a legal matter, turning upon the articles of association. I have no animus against Mr. Swabey, Mr. Brown, or anybody else, and personally I have done all I can in the interest of the company (A shareholder: And for yourself). If that is your opinion you must blame Mr. Swabey, for he will tell you that I wa anxious to retire, feeling the business too heavy; but Mr. Swabey considered that in the interest of the company I should remain, and the engagement that he pressed me into is entirely at your disposal. I have not made any money out of the company, notwithstanding the fact that I have drawn £1,000 a year as salary. I stated to the committee on April the 17th that Mr. Howell had cost the company nothing, as I paid him myself. As to the board, the articles of association provide that before a new director is appointed, seven days clear notice must be given before the annual meeting. Our position during the past year has been that new dynamos have been produced at a cheaper rate than ours made in 1887, and we have had to close a great many contracts which on 1886 prices we had a right to expect. As to patents, no doubt I have obtained experience with this company, but that has not enabled me to work out the Watt system, because I tell you frankly and fairly that the original plans of the Watt system were not my initiative. They came to me, and I financed a certain amount of money on the distinct condition that the Maxim-Weston Company should benefit; but the company has virtually nothing to do with the patents, and Mr. Swabey, more than even Mr. Brown, wanted an arrangement to secure this.

Mr. Swabey: I beg to most emphatically deny that.

The Chairman: The minute book will show, but as Mr. Swabey dissents I waive the point. Of course the future of the company depends entirely upon our arrangement, the provisional verbal arrangement, which was that the company could make and sell the machines at a royalty, but if none were sold no payment would be made for royalty. I am not aware of any patent arranged for on such terms before. As to the accounts, they are made up on the basis of the lines of the auditor, and of the professional accountant who keeps the books. All I can say is that the more you debit to working expenses of amounts incurred in experiments the less will be your chance of dividend and profit. That is a matter affecting the shareholders. Other companies I am told debit patents to the extent sometimes of tens of thousands of pounds, and as to whether our accounts are correct or not, I think it is a matter for an expert and not for an ordinary hard headed business man, because scientific and mechanical principles are dealt with as well as commercial principles. I maintain that

the accounts as prepared are absolutely correct. If you do not have the Watt patents you will lose them, and, provided my advances are paid, they will go out of my hands altogether. You have made certain machines and have expended money upon them under the verbal arrangement, which will be carried out in any case, the machinery remains the property of the company, or the amount expended upon them will be paid you, and there is an end to the question.

A Shareholder: What is the royalty?

The Chairman: A percentage according to the size of the machine. The machine is about half the price of the Weston machine, not more than two-thirds, so that the royalty is not at all prohibitive. To return to the committee. The committee were appointed to confer with the board, it was distinctly understood that it was not an investigation committee; all the books were accessible to the committee except the minute book, and our solicitor, Mr. Hawse, said that the minute book of the board could not be shown to the shareholders. My proposal now is, that in view of the report of the committee, about 20 of the largest shareholders of the company should form a committee representing the whole body of shareholders. I do not think this meeting should continue. We have lost a vast amount of business (A voice: No). A gentleman says no, but recent negotiations with regard to a proposed installation that would necessitate an outlay of £8,000 or £10,000 at Bradford have fallen through because the time for sending in tenders expires to-morrow.

Mr. Klenck: Our business is to receive the directors' report and to elect two auditors in the room of two who retire by rotation and afterwards to transact the ordinary business of the company which was left undone at the last meeting.

The Chairman: What we want, if this meeting is competent, is to find a *modus vivendi* to strengthen the board.

Mr. Klenck: Would it not be more convenient to take that after the report of the committee has been accepted.

The Chairman: I cannot accept the report.

Mr. Klenck: After the report has been accepted or rejected the legal point can be put to Mr. Hawse.

Mr. Hawse: You cannot appoint any other director than a retiring director.

The Chairman: An extraordinary meeting can be called on a requisition representing one-fifth of the total issued capital. I have here a list of some 16 shareholders whose holdings vary from 5,000 shares to 1,000 shares, and if they were formed into a committee to confer with the existing committee and the board, they would be able to determine upon the course of action to be followed with regard to the future position and progress of the company.

Mr. Greig: Such a committee should have full access to the books.

The Chairman: I beg to move an amendment, "that before the report be adopted it be referred to another committee, consisting of the largest shareholders, and that it communicate either to the shareholders or to the board as it may think fit."

Mr. Newton: I see no objection to that, provided the present committee be added.

Mr. G. Howell, M.P., said that he went on the board with the written assent of the board; and if the directors did not do their business it was not his fault. At any rate, he went on the board *bonâ fide*, and had, since he had been there, done his best for the interests of the shareholders, and had endeavoured to bring matters up to the point when the shareholders and the board could resume business relations. Whatever criticisms had been made as to the past did not affect his position; all that had been done was when Mr. Swabey and Mr. Brown ought to have looked after the affairs of the shareholders. He wanted the shareholders to distinctly understand that.

Mr. Marks, as a member of the committee, said it was not intended to cast any reflection upon Mr. Howell.

Mr. Klenck asked if the chairman would withdraw his amendment.

The Chairman: I defer to the request.

After a brief discussion the motion for the adoption of the report of the committee was agreed to.

The Chairman then moved, and Mr. Klenck seconded, the following resolution which was adopted:—"That 16 of the largest shareholders, or as many of them as will agree to act in conjunction with the present committee be appointed as a committee to report to the shareholders as to what is best to be done in the interests of the company, and to take an early opportunity of submitting their report to the shareholders, five to form a quorum."

The auditors were re-elected and a vote of thanks to the chairman concluded the business of the meeting.

Eastern Extension, Australasia and China Telegraph Company, Limited.

THE twenty-ninth ordinary general meeting of this company was held at Winchester House on Wednesday, the 25th instant, Sir John Pender, K.C.M.G., chairman of the company, presiding.

The notice convening the meeting having been read,

The Chairman went through the accounts presented with the director's report for the half year ending December 31st, 1887, a statement of which was published in the REVIEW last week, and said that while they had decreased their capital, they had been increasing their reserve fund. His supplemental remarks were as follows:—The completion of the renewal of the Singapore-Saigon cable has been carried out since the close of the last half year, the cost of which, amounting to about £17,000, will have to be dealt with in the accounts for the current half year. This gives a new cable entirely between Singapore and Saigon, paid for out of revenue. We are strengthening our position in every way; we are strengthening our power of carrying on the work; we are strengthening our position as a company in such a manner as to defy almost any competition that may come against us, and I think our way is to maintain our position, which we have endeavoured to maintain, and which I believe we occupy at the present moment, so that it would be impossible for any other company to come in. During the coming autumn we have some important work to do. We propose to make some alterations in the Madras-Saigon cable and in the China-Australian cables, where we have frequent difficulty and costly repairs. These changes will probably cost £75,000, but it is expected that they will effect considerable improvements in the working and a large saving in the heavy cost of repairs. If we had no repairs, if we had our cables laid on such ground that no repairs were required, we would be able to pay a very much better dividend than we hope to do; but the cost of maintaining cables is a very important item in our accounts. I have before said that we have duplicated, and in some instances triplicated, our cables. At the same time these duplications and triplications give us such a security in carrying our traffic that you scarcely ever hear of any interruption to our telegraphic communication throughout the system. That is the real source of our strength, and that, I have said before, we shall endeavour to maintain as long as it is possible, and as long as we have the confidence of our shareholders. I have mentioned on one or two occasions before that we have had a difference with the New Zealand Government in regard to the renewal of their subsidy. I dare say you have all observed in the newspapers that the financial condition of New Zealand lately has not been so prosperous as one would wish it to be, or as the best friend of New Zealand would wish it to be. New Zealand has a grand future before it, but at the present time they have spent a little more than they were prudent in doing all at once; it would have been better if they had spread it over a larger time. Nevertheless, the work is done, and it will be materially useful in developing New Zealand; and I have no doubt at all that before long we may see New Zealand in the prosperous condition which it has previously been in; perhaps more prosperous, on account of the outlay that has been incurred. The Ministry, however, declined to put the renewal of our subsidy before Parliament, and we had to take the next best course, which was to increase our tariff, so as to recoup us for the outlay. It shows the importance of our system, that notwithstanding the increase which we have made, and which increase, I may say, was not objected to on the part of the New Zealand Government—they found that they could not give us the subsidy, but they did not object to our getting it from the telegraphic public—and the result has been that for the increased tariff we have got an increase of words at a higher rate over our cables, showing that telegraphic communication between New Zealand and the mother country has become an absolute necessity. We have recouped ourselves out of the traffic for what we lost on the subsidy, or nearly so. The next question is as to our relation with China. When I had the pleasure of addressing you six months ago I mentioned that we were negotiating with China. Those negotiations are practically finished; they are finished excepting the signature. The Chinese never move very quickly, and therefore we are perfectly satisfied having established the principle, having come to an arrangement with them as to terms, we are perfectly satisfied to wait, because in waiting we are enabled to put money into our own exchequer that we should be otherwise required to put into the Chinese exchequer, so that as we are losing nothing by the transaction we are in no very great hurry to hasten the ratification of the agreement made with them. The agreements being so fair, so just to them, as they are to us, we are perfectly satisfied that it will be for their interest to eventually ratify them. We have heard a good deal about competition in the Pacific. That may come some day. I never say that there is anything impossible. At all events, soundings have been decided upon and they will extend over a period of three years, so at any rate for that time we shall not be troubled about opposition in the Pacific. But if it should come we are now in a position, which I hope we shall be in then, which will enable us to deal with it probably in such a way as not to make the opposition at all possible, or, at all events, possible in any way to annoy or inconvenience us. There is another matter which it is right you should know, because we are always anxious to give our shareholders as much information as possible. That is, that the Australian Colonies are anxious to have direct communication with this country. I do not object at all to having direct communication there. We are disposed to help them in that direction, and we are perfectly disposed, if we find that it is a necessity, if we find that we can do it with advantage to them and with advantage to ourselves, not to lose sight of it. At the present time we are looking to that question, and, probably if I have the pleasure of addressing you six months hence I may be able to say that some satisfactory arrangement has been made with those colonies. Since I last addressed you we have completed an arrangement with the Dutch Netherlands for a cable 462 miles long from Java. They pay for that cable, which will be a feeder to our system; so that we have done everything we possibly could to promote it and have given them the best of our advice. A duty I have to fulfil is to express to you our great regret at the death of Sir William McArthur, who was intimately associated with this company from the beginning. He

was a man who, in his way, was a most useful member of society, who was well known in the Colonies as well as at home. He was constantly doing good works, a good man of business, and we had the advantage of his association for many years, an advantage which we always highly appreciated. With these remarks I beg to move the adoption of the following resolution:—"That the report and accounts of the directors now presented be received and adopted, and that a dividend be now declared of 2s. 6d. per share, together with a bonus of 3s. per share, both free of income tax, payable on the 26th inst., making with previous dividends, a total of 6¼ per cent. for the year."

The Marquis of Tweeddale seconded the motion, which was put to the meeting and carried unanimously.

Mr. John Denison Pender and the Marquis of Tweeddale who retired by rotation were re-elected directors of the company.

The auditors, Messrs. Deloitte, Dever and Company and Messrs. Quilter Ball and Company were re-elected, and a vote of thanks to the chairman and his acknowledgment thereof closed the proceedings.

Reuter's Telegram Company, Limited.

THE ordinary general meeting of the shareholders in this company was held on Wednesday at the offices, Old Jewry. Colonel J. Holland presided, and, in moving the adoption of the report, stated that the revenue of the past year had been larger by £1,300 than that of 1886, but the expenses showed an increase of £3,400. Hence the decrease in the dividend. In the past year there were several prolonged periods of excitement, entailing considerable outlay which was not compensated for by extra subscriptions as would have been the case in the event of actual war. Admiral the Right Hon. Sir J. C. D. Hay, K.C.B., seconded the motion, which was carried unanimously; and the retiring director and auditor were subsequently re-elected.

The Eastern Extension, Australasia, and China Telegraph Company announce that the coupon on their Five per Cent. Debentures (1880 issue), due on May 1st prox., will be payable on and after that date, on presentation of the same at the Consolidated Bank, 52, Threadneedle Street, E.C. Coupons should be left three clear days for examination.

The West India and Panama Telegraph Company, Limited.—The directors of this company, owing to improvements of revenue derived from exceptional causes and some increase in the traffic, recommend a dividend of 10s. per share on account of arrears of dividend on the first preference shares.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending April 20th, 1888, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,390.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 15th April are £3,022, as compared with £2,373 in the corresponding period of 1887.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ending April 20th amounted to £4,104.

PROCEEDINGS OF SOCIETIES.

The Society of Telegraph-Engineers and Electricians.

(Continued from page 430.)

Mr. T. PARKER, of Wolverhampton, said: I certainly did feel inclined to speak this evening, but this is my maiden effort in this hall, and I feel rather new. I have listened to Mr. Crompton with a great deal of pleasure in some part of his efforts to make clear the cost of cables and various parts of installations with alternating currents, and also for continuous currents, but I would rather have heard more of the experience which has been attained by practice than to have heard Mr. Crompton's personal experience only in this matter. There is no necessity to rejoice, so far as I am concerned, in regard to batteries. I am not a recent convert, for I have spent seven years of my life on batteries, and the firm which I represent are turning out about 5,000 cwt. of them per annum. I would like to have heard something from Mr. Crompton upon the mode of regulation which has been referred to by Mr. Kapp. The figures given as to the cost of batteries I do not take much exception to, for I believe they could be worked out at the prices named if a practical mode of regulation could be adopted. Mr. Crompton speaks of what he has done at Vienna, but does not tell us about the mode of regulation in use there. Again, the matter of 400 or 500 volts does not seem to me at all a sufficient pressure to work with if they are to compare with the alternating current system. The effort which was made at Colchester some years ago seems to have fallen out of notice. Mr. Kapp merely mentioned it and passed on. The effort made there I was to a considerable degree associated with; that is, I was called in to design the dynamos which took the place of the Brush dynamos to run that installation, and I do not think anything was ever published with regard to them. They were designed to give 1,000 volts and 22 ampères, and were run in series from 1884 until the experiment was ended, and there was never any difficulty in respect of them. The mode of manipulating the batteries was simple in regard to putting them in and taking them out, the mechanism being practical and reliable. The reasons for the failure of that installation do not seem to have been carefully studied. The failure seems to me to have been due first to the insufficiency of the number of lights attempted, and perhaps secondly to the mode of insulation used at the cells. The cells then were not so good as they are now. Mr. Crompton said something to us about the wonderful perfection of cell to which he has arrived, and I should like to see or hear something more of it, and should like to send cells from Wolverhampton to be tested against anything Mr. Crompton has or could supply to settle this question. We have been enabled to carry out some improvements in these cells, which we shall shortly be able to make public, and which will give a greater life to accumulators and enable us to discharge them at a much more rapid rate. I think the Colchester experience in regard to batteries has been the longest which has yet been had; it was certainly longer than what Mr. Crompton can boast of—nine months—and I do not see that he has done more than has been done in many private installations. The manipulation of a battery station is a difficult thing. I do not say the cost stands in the way at all. I have had something to do with alternating currents, and have read a great deal that has been published upon the subject, and my experience and what I have read enable me to say that a battery system could be carried out at very nearly the same cost as the alternating current system, and possibly it may be preferable. In regard to alternating currents, perhaps one of the most unique experiences, and one which may answer the question troubling the minds of many people at present, is that in connection with the Eastbourne installation. There we have an instance in which two or three electricians, hard-working, good men, have designed and carried out, for the first time in their lives, an installation which has been running nearly two years, and there has been no accident with it, no mishap, and no stoppage. There is no duplicate plant, and yet it has run from the first minute it was put in until now without any stoppage or cessation of the lighting. That is a most creditable thing to be able to say of the people connected with it, Mr. Lowrie and Mr. Hall. I myself designed the dynamo and put it there. These are things which are now matters of history and experience, and the right and property of us all as electricians. I do not say these things with the view of throwing up fireworks for Elwell-Parker, but Mr. Crompton dwelt upon this, I thought I might tell you of my own experience.

Mr. W. H. PREECE said: The broad question which Mr. Crompton brought before us is being rather lost sight of in the cloud of details, and in the criticism of certain estimates that he has brought forward. There is no question that occupies us as electricians at the present moment of more paramount interest than that of the proper distribution of electricity through areas that want to be lighted. There are over this country at the present moment some 30 or 40 corporations and communities which are anxious to introduce electric lighting. Some of them are guided and controlled by consulting engineers, and these consulting engineers are in the unpleasant position of having to postpone their fees by advising their clients that the time has not yet arrived when they can say to them "Go ahead!" I am in that position. I am in this position, that I have held back for the past two or three years some very large installations because I have not made up my mind whether the best system to adopt is that of secondary generators or that of secondary batteries, and I think I shall fulfil the purpose of Mr. Crompton if I give some of the reasons which have kept me balanced like a see-saw between secondary generators one day and secondary batteries the next. Now, if I have had any prejudice or any feeling at all, it would be in favour of secondary batteries. I do not suppose there is any man present in this room who has had more practical experience of the working of secondary batteries than I have myself. There is no form of secondary battery that I have not tried: there is no form of secondary battery that I have not burst up. There is therefore nobody perhaps who can speak with greater confidence of his own performance with secondary batteries. Now, in the first place I commenced at the same time as Mr. Crompton did. I went over to Paris when Faure first brought out his battery, before any description of it was published, and I formed, as I had often formed before, a wrong opinion about it. I thought it was the biggest nonsense I had ever seen, and I came back and would have nothing to do with it. Shortly afterwards I found that others were more far-sighted; they took it up and brought it forward, and as my knowledge of it has increased day by day I have come to regard it as one of the most beautiful instruments the electrician has at his disposal. My experience of the secondary battery is threefold. I have used it in my own house since the early part of 1884 for lighting purposes, and I can tell you this, that for the last two and half years I have never seen such a flicker in any part of the house as we see here with the gas. There has been never a fault—never a disturbance. The reason simply is that the batteries have been taken care of. If anybody imagines that the secondary battery can be put into a cellar, a man going round once a month to look at it, and that that battery will remain in working order, he makes a

very serious mistake. A battery is a thing which wants constant attention. You must regulate the current going into it and that coming out of it, and if you treat that battery as you would treat a well-trained infant, it will grow up to its old age in the way it should go. Mr. Crompton has omitted one very serious observation with regard to secondary batteries. It is that you cannot take out of a battery all that you put into it, that the efficiency of a battery is a variable quantity. I have had batteries that have given me 90 per cent. efficiency. That is, I have succeeded in getting out of them just 90 per cent. of what I have put in. But that has only occurred when I have charged the battery with a small current and taken a small current out of it. I mean when you charge a 15 L E.P.S. cell with 15 ampères, and take out of it 10 ampères. I think you will get out of it 90 per cent. efficiency. But if you took such a battery and put in 30 ampères and expect to get out 25, you will be greatly mistaken. In fact, I do not think you can calculate under these circumstances upon an efficiency of more than 60 per cent. Now I am afraid that in his figures Mr. Crompton has not quite taken notice of that particular point. There is another point connected with batteries which I should urge very strongly in their favour, and that is their extreme safety. You have in a battery something that is absolutely reliable. You may have, from causes which have been mentioned, a failure in a single cell, and in a set of 25 cells the failure of one cell may drop your potential down about 2 volts, but that does not make very much difference. The battery will maintain itself for a good many years in thorough working order. I say a good many years, but I ought to draw a line somewhere. There is an end to a battery; when that end comes I do not know. I have had, as I have told you, batteries of various kinds; but I have now in the Post Office a set of 25 cells of the original Planté form, as manufactured by my friend Mr. Parker. I have had them four or five years, and they are perfectly good at the present time, but they have been treated gingerly. If they had not been I think they would have come to pieces long ago. Again, I have in my own house 25 E.P.S. cells as perfect to-day as when, 2½ years ago, they were supplied to me. During the whole of the 2½ years I have only had two faults, both of which happened in the night-time, when the light was not in use. One arose from the flaking of the negative cell falling across and short-circuiting one cell. That happened after the battery had ceased to act. It was removed next morning when the batteries were examined. I examined every cell every morning. When you test them by the hydrometer you know at once by the density of the cell whether anything has gone wrong. The second arose from the falling of the peroxide. The peroxide in all these cells falls like a gentle shower. When the battery is discharged the peroxide is constantly falling, and there is a gradual accumulation of this stuff at the bottom. In this particular cell I took the precaution of having the peroxide weighed, and found it was 2 lbs. If in 2½ years 2 lbs. of peroxide is accumulated at the bottom, how long will that battery last. That is a rule of three sum which anybody who knows the amount of peroxide in a battery can calculate. The quantity is 16 lbs. I have come to this conclusion, that if a battery be carefully attended there is no earthly reason why it should not last ten years. Depreciation is one of the greatest points for consideration in connection with batteries. The depreciation of a battery may be taken at 10 per cent. I do not raise any objection at all to Mr. Crompton's figures. I think he is extremely fair; I think he has given all he possibly can give in favour of secondary generators and he has erred, if at all, on the wrong side as far as he is concerned in regard to batteries. It is not at all a question of the relative prime cost of the two; it is not even so much a question of the relative annual cost of the maintenance of the two. But I think there are some points which he has not given due weight to that ought to be taken into consideration: one is the depreciation, the other the loss of energy in batteries. But there are other losses. There is the loss in leads, there are losses in the engine house itself, there are the losses in the battery; and I think if you add up the two you will find that the losses in favour of the transformer are very much better than the losses in favour of the secondary battery. Therefore, if we take the loss of energy, I give my vote in favour of transformers. Batteries, however, have this enormous advantage over secondary generators, that you always have a store of energy to draw upon. Night or day, in season or out of season, in winter and in summer, whatever may happen out of doors—the man in charge of the sewers may turn up the streets and break down the conductors—you have your batteries safe and independent. Your engines may break down in the central station; your batteries have storage and you are always independent. There is no doubt that in future motors will be used to a very large extent for household purposes, for sewing machines, and for many other purposes. With batteries you always have something to work your motors; with transformers, where are you? There is something we want: it may come in the future. That is a motor to work with alternating currents. In nearly all the papers I have read on this question which have been brought before societies in America, the argument is always upon what is going to be done in the future. There is a capital paper referred to in substance though not by name in Mr. Crompton's paper, which was read by Mr. Leonard before the Electrical Institute in America. He argues in favour of the three-wire system against the transformer system, and nearly all his argument is based upon what is going to be done in the future in improving the glow lamp. Therefore the two great reasons in favour of batteries as against transformers is, that batteries give you an invariable store of energy, and a means of working motors. But then secondary generators have got something on their side. They enable you to use very high differences of potential, and high E.M.F. leads to cheap conductors. This has not been shown to the advantage that it might have been by those who advocate the transformer system. The use of high E.M.F. also means a very small loss of energy in your conductors, and it enables you to go to great distances. And this is one of the great points, that where you are able to go to great distances by means of this high E.M.F., the local authorities are quite out of it. They cannot buy your system up, for if you carry your conductors through various parishes and through the districts of several local boards, when the 21 years, or as we hope the 42 years, expire, there will be no local authority that could possibly buy up a system thus distributed. I should like to adjourn this discussion here, for I feel I have more to say than can be condensed into the next few minutes, but I fancy I could at the next meeting, by preparation, say all I want to say in ten minutes.

The meeting then adjourned until the 19th inst.

At the adjourned meeting on Thursday, April 19th,

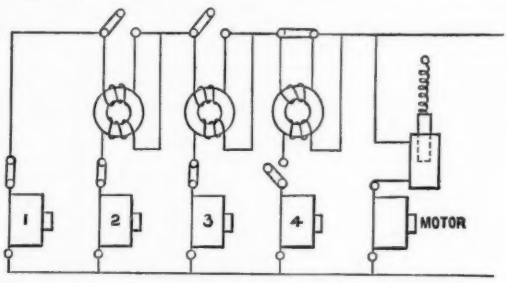
Mr. W. H. PREECE said: Last time I said nearly all that I could say in favour of batteries. I pointed out that the three principal arguments to be adduced in favour of distribution by means of batteries were: (1) convenient means of storage, (2) the utilisation of currents for motor purposes, and (3) that their use enabled the power to be supplied during the whole 24 hours of the day, which enabled a smaller plant to be used during the hours of high pressure indicated by the load diagrams. Three arguments can also probably be adduced in favour of transformers, viz.: (1) that they allow of the use of much higher electromotive force, (2) they are such an exceedingly simple apparatus that they can be stowed away in cupboards, or laid underneath the pavement in a dry well, thus economising labour in supervision, and (3) in point of efficiency the transformer is very much higher than the battery. On the latter point Mr. Crompton has agreed that not more than 60 per cent. can be reliably calculated on for batteries, while, although experiments show that as much as 92 or 95 per cent. can be obtained with transformers, still if a margin for practical purposes is allowed, transformers have a very much higher efficiency than 60 per cent. The argument that the battery enables small motive power to be used as against that required by a transformer is about as broad as it is long. Something must be provided to give the energy when the load diagram attains the high peaks shown to be required, and whether capital be invested in additional machinery at the central station, or distributed over the lighted area in the shape of batteries, it is the same thing as regards finance. The tendency of the discussion so far has rather been to decry the good that has been done by the alternating current system as employed for transformer purposes. The experience of the past in this and other countries cannot be ignored, and we cannot too much admire the pluck and determination with which Gaulard, assisted by his colleague Gibbs, pursued, in spite of the opposition of all the electrical world, the secondary generator or transformer principle. That principle has been taken up by the Grosvenor Gallery people, who have been the pioneers in electric lighting by its means, and have so far been benefactors of the science, inasmuch as they have carried the light to longer distances than could otherwise have been reached in spite of Acts of Parliament and of the opposition of vestries. Mr. Hammond is present to-night, and I hope he will tell us something about the installation on the same principle at Eastbourne. The principle has been largely extended on the Continent, and still more in America. We are all very pleased indeed to find at our table to-night Prof. G. Forbes, who returned from America two days ago, and from whom we shall be anxious to hear what has been done in this direction on the other side of the Atlantic. Mr. Crompton used the argument that the secondary generator system involved considerable consumption in steam, and pointedly asked, on a previous occasion, Mr. Mackenzie for information as to the tons of coal used per lamp in the Grosvenor Gallery installation. That implied that there was an enormous waste of coal in carrying out the secondary generator principle; but while there may be some truth in Mr. Crompton's suspicions, I think that any excess of consumption in steam in the central station is not necessarily the consequence of that principle as opposed to the secondary battery method, but rather to the engineering principle adopted in carrying out the engine working at the central station. An American friend has said that the money is "lost or made between the coal shovel and the belt," meaning that the pecuniary loss is incurred in the engine-room and not in the distribution of the current. This question is quite apart from the relative advantages of batteries and transformers, and is a question of putting all the power in one or two large engines or distributing among a series of small engines that can be brought in to work at different times of the day to meet the variations of the load. Considerable advances have been made in the economy, construction, price, and character of high-speed engines, and we are justified in hoping that the solution of the question of the proper construction of a central station is in the near future a simple one. Small engines and small dynamos must be used if economy is desired, instead of concentrating the working into a 5,000 horse-power engine with a 4,000 unit dynamo. One question, which is rather apart from the subject we are discussing, but which deserves our attention, is as to the relative advantage of 30 watt, or 10 candle-power lamps, as opposed to 60 watt, or 16

candle-power lamps. I am a strong advocate for the use of small candle-power lamps. The use of 30 watt lamps at once doubles the capacity of the dynamos. Some step should be taken by this society in regard to the voltage at which the lamps are at present issued. We have 20, 30, 42, 50, 60, 80, 90, 100 and 110 volt lamps, and one rarely goes to two installations and finds that the lamps used are of the same voltage and character. Some definite law is required on this matter. In America they are coming very much to the use of a 50 volt lamp, because it is said that a 50 volt lamp has a longer duration than a 100 volt lamp, on account of its thicker filament. The point I wish to urge to-night is that the question before us is that of the distribution of energy, and not so much that of the arrangement of the central station. A certain amount of energy is generated at the central station, and it is distributed over a large area in various places in the form of light. Which is the most economical, to distribute that energy by means of batteries, or by means of secondary generators? Practical men must be governed by results, and we prefer that others should carry out the experiments for us when their cost is considerable. At the present moment men like myself, who have often to decide what course shall or shall not be followed, are obliged to leave our decision dependent on the result of experiments. If I were now asked to design a system of distribution in any particular neighbourhood from a central station, I should first of all consider the compactness of the neighbourhood. In the City of London for instance, I should without the slightest hesitation say that in such a close neighbourhood the best means would be the Edison-Hopkinson 3-wire system. But in a scattered district such as Wimbledon, where the central station must be near the river, and where the distributing mains must be carried for a distance of 10 or 12 miles, I should recommend the secondary generator system. But that opinion does not prevent me from keeping my mind open on the question of secondary batteries, for which I am a great advocate, and about which I am anxious to see the results of the gigantic experiment in that direction being carried out by Mr. Gordon. But until we know that a system of distribution by means of secondary batteries is feasible and perfectly practicable, assured by practical experiment, I, as a practical engineer, will withhold my opinion upon them, and give it now in favour of secondary generators.

Sir DAVID SALOMONS, Bart.: In Mr. Kapp's remarks last meeting, he raised objection to Mr. Crompton's figures of the cost at which accumulators could be purchased. I have looked into the matter and find that they are within the mark, and Mr. Parker acknowledged that the price of £16 per kilowatt was not unreasonable. I consider that the efficiency might fairly be put down at 70 per cent. instead of 60 per cent. Mr. Preece stated that the paste fell at the rate of 1 lb. a year, but from examination of old cells in my possession, I find that after 11 months there was not 1 oz. loss in one set, and in another set, after between three and four years work, there was not so much as 1 lb., so that the probability of their lasting is far greater than some people imagine, if the cells are properly looked after. Instead of undercharging the cells, it is the rule now to overcharge them, and the plates have been found to last much longer. The margin of loss of 4 per cent. in the distributing mains allowed by Mr. Crompton is far too large, and from all I can learn 2 per cent. would be sufficient. I was sorry to see that no mention was made by Mr. Crompton to the B.T.K. system, nor to a pamphlet issued by the Electrical Power Storage Company. Both these were attempts to carry out exactly what he now proposes to do, but they were not advanced beyond the first stage. To work without some means of storage is like working a gasworks without a gasometer, and I am not so bigoted as to say that transformers have no use at times in certain places. In the Grosvenor Gallery installation the people behind the scenes always speak of the wonderful satisfaction given to their customers; but the customers give a different opinion, seeing that their lights frequently go out for a short time, and the excessive current causes great destruction of lamps. A friend of mine who has only four or five lamps in his house has, I think, had as many as 50 new ones in a year. In Mr. Crompton's curve he has entirely forgotten the possibility of the day arriving when motors will be used largely, and then the estimate of power used will be altered very considerably. I once made an experiment so as to work a motor with alternating currents; but although I could make the motor rotate, the enormous heating of the armature prevented success. Perhaps if the magnets were made with wire in some form that they should not be heated by the reversals, an alternating current motor could be produced, and I throw out that suggestion because sometimes rational results are obtained from trying absurd ideas. When batteries are used for central station lighting, they should be put with groups in parallel, so as to prevent a breakdown; accidents will happen, and with a series battery a leak in one cell may cause a breakdown. As to regulation, no doubt some kind of regulation is essential. I believe the Howell cell allows of a very large excess of current, but I have not seen that cell yet, and I hope that I may have an opportunity of examining it. With the cells at my house I find that by a very moderate outlay, about 1 per cent. on the prime cost per annum, old cells can be renovated to a condition almost equal to new.

Mr. R. E. CROMPTON: My paper was necessarily incomplete on account of the time at my disposal, but as so much is going to be said on the subject of the regulation, I may at once anticipate the remarks of some speakers on that point. The regulation of groups of batteries placed in series is the simplest possible thing, and has been most successfully carried out at Vienna, without any hitch, from the commencement. More cells are brought in or taken out by the simple turning of a wheel* which changes the contacts of the cells which are led to the shaft to which it is attached. In large installations the apparatus is duplicated, one being used for charging and another for discharging, and there is no loss whatever in the operation. This arrangement can be made automatic, and Mr. Willans has offered to supply a governor to operate it. Hitherto the man in charge of the cells has worked the regulator, and as the changes are few there is no difficulty in his doing so. People are saying that I am not showing the Howell batteries. I have never refused an application to see them either to rival or friend, and I do not think it is fair to say that they are invisible.

Mr. SWINBURNE said the great value of Mr. Crompton's paper lay in the data being those of an experienced engineer gained from practice, instead of mere paper work, but he would not take up the time of the society with compliments and platitudes. He was afraid Mr. Crompton had, or rather thought he had, got his information as to coupling alternating machines in parallel from him. The question depended entirely on the design of the machine. Such machines as the Ferranti could not be run together if the engines did not give exactly equal power. Westinghouse machines could be coupled with fairly large variations of load. Others, such as the Foreland machines, would take a still larger variation. The diagram shows an arrangement for allowing any machines to be run in parallel with large differences of load. The first machine, 1, is put directly on the mains. The second, 2, works through a sort of transformer with the main circuit forming one coil, so that if the machines are in step and taking equal load the core is not magnetised. If they begin to get out of step the transformer arrangement controls them. Machines 3 and 4 are cut in with their controllers. A similar arrangement is used for motors. As shown, what Mr. Gordon calls a "choking coil" with a movable core held out by a spring is inserted. As the load increases the core is sucked into the coil. There is no difficulty in seeing if the machines are in step before switching in. So many methods used in America are well known that it is needless to discuss any. The efficiency of transformers was of little importance; the question was keeping constant potential on the lamps. The transformers will not "compound up," so the primary pressure should be increased in amount equal to half the full load loss, so as to split the difference. Mr. Swinburne did not think the importance of motors was sufficiently taken into account. One difficulty was in starting alternating motors. A laminated field exciter can be used to start the motor, and switched over when the right speed is reached. Little was known about insulation on alternating



currents circuits. It was possible that insulation which gave way with 2,000 volts continuous would stand the same alternating, the harm done in one direction being undone next alternation, and so on. As to the drawback of being unable to use storage with alternating systems he could only quote Mr. Mordey's dictum: "The great advantage of alternating currents is people cannot go and put in accumulators." The weak points of Mr. Crompton's system was the high pressure led into houses. He believed alternating currents were best for scattered lighting with overhead wires, direct parallel for dense districts and step-down dynamos or "dynamotors" for such cases as that taken by the author. Dynamotors need little or no attention, and they will regulate, or even compound up, with a varying primary pressure. They get over the high-pressure difficulty, and have the doubtful advantage of admitting accumulators. The safety of people on transformer secondaries had been already considered. To make the installation safe, however, none of the circuits should be earthed permanently, but a contact should occasionally be automatically made between first one terminal and earth, then the other terminal and earth. In case of a leak a bell would be left ringing, no further contact being made. In the case of alternating currents the contacts are made through a toothed wheel synchronising with the machines, so that capacity shocks do not interfere with the working. If a man makes an earth contact he is then immediately shunted to earth and set free.

Major-General WEBBER, C.B., R.E. (Retired): I would draw attention to the system proposed by Mr. Crompton for laying down his underground conductors. He proposes to make subways with an interior cross-section of about two superficial feet, from the roof of which insulators will be suspended to carry the bare conductors. I cannot conceive that such an arrangement would be watertight. For the first two years probably not much trouble would arise as regards the insulation of the conductors, but, speaking from a large experience, I feel sure that during that

* See Specification No. 275, 1887.

period the insulators would be covered with detritus of various kinds, and the subway would become in such a condition, from various causes, that the insulation would disappear. The copper is uncovered but it is inaccessible, except at contact or connection boxes, without taking up the roadway. Under these circumstances I hope that electrical engineers will take the example of the experience of those who have laid down conductors for telegraph purposes and place their conductors in conduits through which they can be readily withdrawn. I regard the maintenance of underground conductors as only possible when they can be withdrawn with ease. Mr. Crompton meets us in his paper by a most clinching argument in favour of his calculations, that he will always do the work himself for the money. That is a very good argument, and I think that looked at from the point of view of the proportion which his estimate for the distribution represents to the total he is not extravagant. Mr. Crompton allows 20 yards of main for each house, or 20,000 yards for 1,000 houses. I think that is susceptible of a correction to the extent of three yards a house. As regards insulation, in the example in which the cross-sectional area of the copper is half-an-inch, he makes the insulation in one case cost £35 17s., while in the other case, that is his own subway, it is put down at only 4s. 6d. I think the latter is too small, and the former is certainly too large. The use of bitumen concrete has, I am very glad to say, been adopted to a certain extent by Mr. Crompton in his installation at Kensington Court. By its use the conductors can be withdrawn when desirable, and there are conditions in its use which are paramount as against the subways.

Mr. SIDNEY F. WALKER: The object of this paper is, I take it, to help us in the onward progress that we are hoping to make with the electric light this year. We are all leading on to larger and larger installations, and therefore all these matters of transformers *versus* accumulators help us very considerably by the experience and by the side lights that they throw even upon installations of less than 10,000 lights. But before these matters help us, I think progress must be made with the lamp itself. If a 200 volt lamp can be produced the cost of the copper in the cable itself will be quartered, and if a 400 volt lamp can be produced it will be quartered again. I am afraid that the varied voltages of the lamps referred to by Mr. Preece are unavoidable, they are merely the results of the progress that has been made. My experience is that the first thing to be studied is the efficiency of the service; when you have made the thing good you will always get paid for it. The consumers, or at any rate a sufficient number of them, will always pay sufficiently for your going on, but they will not put up with breakdowns every now and then such as Sir David Salomons mentioned. You may hold forth to a consumer that you have 99·9 per cent., and he may be very interested in it, but if it breaks down and he has no light for a few minutes every now and then he will vote that it may be a marvellous thing, but it is a marvellous nuisance. The great objection to transformers is, I take it, that before you can deal properly with a service of 2,000 volts and take it into what one may call every day life, as gas is taken, you must face the problem of providing efficient insulation for it. I do not think that any cable or dynamo at present in existence is properly insulated for 2,000 volts. It is not a question of insulating temporarily but practically for as long as the service is to last. I think Mr. Crompton is quite right in pointing out that the margin between heavy cables which must be used with low tension currents, and the lighter cables that may be used with higher tension currents, is not so great as it seems if it is not actually on the wrong side. Take a manufacturer's price list and compare the light insulation, which is only an avoidance of contact, with the heavy insulation, which must be used for underground work, the heavy insulation is ordinarily double the light insulation, the copper being the same, and that is not an insulation for 2,000 volts. I agree with General Webber's remarks as to Mr. Crompton's method of putting down his cables. Leakages and other things happen to underground wires, and if the conductors cannot be withdrawn or got at trouble will arise. I would throw out the suggestion that in place of using large cables it would be better to supply a cable consisting of a number of smaller ones so that if the practice of using a number of small engines and small dynamos is adopted, each dynamo could be connected to its own cable instead of delivering into the main. My experience of continuous current dynamos in parallel is that they do not work properly together, if one dynamo happens to be half a volt in advance of the other, it will take a much larger current than its fellow, for the simple reason that the second cannot deliver until the first one ceases to compound.

Mr. ROBERT HAMMOND: I consider that the question raised by Mr. Crompton is the crucial problem which confronts all those who have to do with central station work, and has confronted us in the immediate past. Eastbourne has been mentioned, and I may say that in lighting the Town Hall there some two years ago the problem was to put some 300 lights down on the condition that any number of lights could be left burning—10, 20, or 30 in the committee-rooms, or the whole going at once. Under the group system that we were then working it was impossible to carry out that plan, and we had to consider whether it was best to put batteries into the Town Hall and charge them with our high-tension current, or to put down converters or transformers. At that time the choice of transformers was much limited, and having decided upon transformers, our engineer, Mr. Lowry, had to practically make his own transformer, and the result has been that the lighting of the Town Hall at Eastbourne is an installation that we can look to with great pride. All who know that installation will have seen that we have been able to carry out this problem most perfectly by means of transformers, and I must say that, looking to such lights in the profession as Mr. Crompton, I was depressed to find on the first page of his paper that the installation at Eastbourne, where we have been working for six or seven years, is characterised, not as an honest attempt to carry out permanent lighting, but as "confessedly carried out in a temporary manner for the purpose of popularising the electric light and inspiring the confidence of the public in supply companies as a form of investment." This appearing in a scientific paper surprises me, because, though I do not pretend to be very scientific, if we have struggled for anything during the last five or six years it has been to pay a dividend to those who have invested money in the companies. Had Mr. Crompton looked at our list of shareholders he would have seen names which would have prevented him making that statement, which I cannot help feeling was a piece of unkindness, because in the preceding paragraph he says, "It is hardly to be wondered at that what little knowledge exists on this subject should be confined to the few who have lighting stations under their immediate charge." And yet in the next paragraph he says, "do not take any notice of Eastbourne—they have only been carrying out an installation for several years; nor Brighton, nor the Grosvenor Gallery, because they are only a set of advertisers." As he has told you to take no notice of them I presume that he has taken no notice of them in preparing the facts for his paper, and therefore I will tell you one or two facts connected with these two central stations, facts which I do not think you will gather from Mr. Crompton in his reply, since he has omitted them in his paper. In the first place, we are working with transformers. It may be on a small scale, some 2,000 or 3,000 lights, but I have learned that to start a central station one must be content to do scattered lights at first, and to gradually put down additions of 50 or 100 lights. In estimating for a central station in London I have had to consider the question over again, and again I come to the conclusion that the transformer system is better than the battery system. Mr. Crompton says in his paper that in a transformer system three shifts of men are required. I was at Brighton last night, at the busiest time, when the lighting was fully on, and there I saw one engine after another put down until there was only one engine running for the load, and the labour expended was absolutely proportional to the load on the circuit. Again, this morning I looked in at the station and found only two men at work, and people who say that with a transformer system it is necessary to have three times the normal staff are talking of what they would know very much more about if they went down to Brighton and Eastbourne and learned the facts. Therefore as to economy of working, Mr. Crompton is as far out as he is as to the motives inspiring those installations for the past 5 or 6 years. The Grosvenor Gallery people can very well take care of themselves. I am just on the point of placing the order for our first London station, and if Mr. Crompton can convince me that his is the best plan, I will put past experiences aside and adopt it. It has been said that with the battery system a reserve is always ready. What is that reserve? It is a chemical storage, and I ask which is the better to rely upon, a chemical reserve or a mechanical reserve? At Brighton we always have a second engine with steam up ready at any moment, and I would ask what probability there is of a properly looked after steam engine bursting up in the air without giving some warning. My experience is that they always give warning, and if they do not actually ring a bell, such as Mr. Swinburne has suggested to-night, a little leakage will tell the practised eye of the man in charge that something requires attention. There is plenty of time to bring in the second engine, and we have never been so surprised at Brighton that we have had a stoppage of the lighting through not being able to rely upon our reserve force. That is the only perfect method of having a reliable and continuous running by keeping power ready to be drawn in at any moment without putting into the circuit those wretched accumulators. Some of our outlying districts, though Mr. Crompton does not know it because he has not been there, are run by accumulators, but our experience of them tells us that they are the one portion of our system that we are afraid of. Accumulators on paper are splendid things, but in practice we know that instead of the efficiency Mr. Crompton mentions of 80 per cent., we can only get an absolute day to day efficiency of 60 per cent. In point of efficiency the comparison is in favour of the transformer, and as to the economy of working we are just as well off, because we can lower our wages, which do not go up with the curve. I could show Mr. Crompton converters at Eastbourne giving 95 per cent. efficiency, and any transformer content to give 30 per cent. must be an atrociously bad one. He says that the efficiency of a converter goes down as the load diminishes, just so; but when converters are working at a small rate of output their internal resistance will be such that you will get a greater output in electrical horse-power. I am anxious to hear what Prof. Forbes can tell us as to what is doing in America, especially as to whether it can be said that converters with a light load ever fall from their high efficiency down to 30 per cent. efficiency if they are thoroughly well constructed. As regards depreciation, our experience at Eastbourne is dead against the 10 per cent. set down by Mr. Crompton to be put aside for depreciation on converters. We do not want 10 per cent. on dynamos, and why put down 10 per cent. on these silent things that have no movable parts, when only 15 per cent. is set down for the depreciation of accumulators. Therefore on these four points, the load, reliability, efficiency and depreciation, our experience is dead against Mr. Crompton's figures. When Mr. Crompton says that "Eastbourne, Brighton and, in fact, all those which distribute by means

of overhead wires," one would imagine that the system at Eastbourne is overhead, but it is underground. We have some seven miles of mains underground, and in regard to Mr. Sidney Walker's remark that the insulation must break down under 2,000 volts, I may say that that is our charging current, we do pass 2,000 volts through and live through it all. I must say that where experience enables one to check Mr. Crompton's figures on the four or five points I have mentioned, one feels that not much confidence can be placed in them.

Mr. A. P. TROTTER: Mr. Crompton has, I think, rather shaken the faith of a good many of those who rely on transformers as the system of the future; many of us feel that he has thrown quite a different light on the matter, and I, for one, should not like to say that batteries will not be part of that system. But there are several points which have already been raised, which show that the time has perhaps hardly come for this. I do not know if the diagrams on the wall represent a station where motors are being used,* but, as has already been pointed out, if motors are used, the daily consumption will certainly be as high, if not higher, than what we see on the diagrams. However, we have not got alternate current motors yet, and Mr. Crompton has made a great point in speaking of what has already been done, as against what we hope to do. Perhaps one of the most serious objections to batteries is that of their efficiency and their life, but when the time comes for battery makers to give an absolute guarantee and to undertake to repair and to keep in order, without stopping the current, the batteries which they supply, for a sum of say 10 to 12 per cent., we shall be in a very different position. People will hardly like to sink so much money as Mr. Crompton recommends upon batteries, judging from the experience that we have had during the last three years. As to the efficiency, we know that 60 per cent. is about the usual thing for a battery which is at one time charged, and at another discharged. Mr. Crompton has given us a very different figure, viz., 80 per cent., and I hope in his reply he will explain if it is due to the short length of time during which he is really discharging from his battery that this very high efficiency is obtained. The question of reserve has already been discussed, and it seems much better to have separate engines and dynamos than a battery reserve, unless two sets are used, and then no doubt troubles arise and there is the double expense. If you have six dynamos of 100 kilowatts each, you always have one or two of them with the steam up, and either just ready to start or having lately stopped, and except at the short time of full load you will always have the opportunity of turning another one on within a few seconds, and even at the full load there should be at least one in reserve. It is most discreditable in this country that at the present time there are so few installations with a single dynamo and engine in reserve at the time of full load, and perhaps as much harm has been done to electric lighting on account of the absence of such a reserve, as from any other reason. In the case of waterworks where they have perhaps two engines to do the ordinary work, and three for full load, there is always one in reserve, and in a central electric lighting station with six or eight 100 kilowatt dynamos with one in reserve, there will be ample time for overhauling and repairs. I would like to ask Mr. Crompton why he has put down 60 volts for the lamps at the transformer station. It makes some little difference to the calculation, but what is more important in working out the comparison is that he has assumed that two out of every three houses will at no distant date be wired and running. This is rather unfair to the alternate current system, because if we have for some years to come only two out of ten houses, it makes an enormous difference in favour of the transformer system. Again in speaking of the very high insulation required for the high volts, is it necessary in the face of these most valuable tables that are given in this paper, to go so far as 2,000 volts? A great deal has been said about the copper varying inversely as the square of the volts, and so on; but considering the percentage of copper in the tables before you, its value is a ridiculously small amount, and if you take 3,000 volts, as has been suggested by some, instead of 2,000 volts, you get about 22 millimetres instead of 50 millimetres for the area, and you only save 22 per cent. of the total cost. No doubt the proportion of copper in the two cases is as 4 is to 9, but still according to the figures in the table No. 1, the cost will be about £11,200 against £14,270, and if you reduce down to 1,500, which is the point suggested by Pro. Elihu Thomson as the limit of high volts, you get 90 millimetres, which would cost £90 per 100 yards, or an increase of 26 per cent., according to Mr. Crompton's figures. I quite agree with Major-General Webber, who has pointed out that the bare copper seems likely to get into difficulties, and I should say much more so than a properly laid cable in a good tube or culvert, and it certainly seems hardly fair to give a higher rate of depreciation for the bare copper than for the insulated cable. Mr. Kapp has spoken of large transformers which are "banked" on a common network, but he did not suggest what should be done when one breaks down and throws a heavier load on the others, no doubt he thought of that before suggesting the method. But, supposing that these large transformers are put down at the present day, when only two out of ten houses are taken up, when the time comes for two out of three we can surely afford to get a room in a mews, as suggested by Mr. Crompton, and probably the room over it can be had when the time comes for exchanging them for batteries and an attendant. It is quite possible that the time may come when batteries will be used to the exclusion of transformers, and then the only change will be in the dynamos and in the transformers, which are not a very serious part of the whole; the houses will be ready wired and the mains might be arranged so as to be available for either system. A question has been raised about the difficulty of working with high volts with batteries, and I see no reason why Mr. Crompton should not go further with his high volts and put down yet more batteries, for nothing could be easier than to run several dynamos in series, for we all know that this is not a difficult matter—certainly not half so difficult as to run alternate current machines in parallel. There should be no reason why in the future, when we come to something like unanimity on the subject, several stations should not be thrown into a general system, or, at all events, one district could help another, as is done by the wireworks in the North of England.

The discussion was then adjourned until April 26th.

* Dr. Fleming informs me that this is the case.

NEW PATENTS—1888.

2313A. "Improved means for obtaining a uniform continuous current from dynamo-electrical machines." S. Z. DE FERRANTI. Dated February 15.

5127. "Improvements in electric telegraphic apparatus for transmitting and receiving signals on board ship or other places. J. S. GISBORNE. Dated April 6.

5131. "A magneto-electro storage motor." C. A. RANDALL. Dated April 6.

5162. "Improvements in electric generators." W. M. MORDEY. Dated April 7.

5182. "Improvements in telegraphic transmitters." R. C. STONE and J. GILFILLAN. Dated April 7.

5191. "Improvements in storage batteries." H. EDMUNDS. Dated April 7.

5196. "Improved means for conducting and collecting currents in electric rail or tramway systems." M. H. SMITH. Dated April 7.

5201. "Improvements in apparatus for effecting by introduction of a coin production of electric light for a certain time." D. H. DAVIES and J. M. TOURTEL. Dated April 7.

5233. "Improvements in fusible cut-outs for electrical circuits." A. H. WALTON. Dated April 9.

5259. "Improvements in electrical heating." J. V. CAPEK. Dated April 9.

5377. "Lubricators actuated by electro magnets." J. M. CROOM. Dated April 11.

5390. "Improvements in velocipedes and other vehicles propelled by electricity." J. SHERRIN and J. V. SHERRIN. Dated April 11.

5393. "Improvements in galvanic batteries." A. F. ST. GEORGE and C. R. BONNE. Dated April 11.

5421. "Perpetual motion and electric current generator." W. ROBSON. Dated April 12.

5433. "Improvements in electric matting." T. PREECE and T. R. ANDREWS. Dated April 12.

5493. "Improvements in that class of lights known as 'search lights,' the same being applicable to other lights of an analogous kind." W. HARVIE. Dated April 13.

5522. "Improvements in telephonic apparatus." A. H. G. SEGNITZ. (Communicated by E. Brand, Brazil.) Dated April 13.

5528. "An improvement in plates for voltaic batteries." E. HERMITE, E. J. PATERSON and C. F. COOPER. Dated April 13.

5529. "Improved construction of reflector for use with incandescent electric lamps to facilitate its removal or re-adjustment." P. G. MERRY. Dated April 13.

5531. "A new or improved system of electric lighting and apparatus therefor." J. G. STATTER. Dated April 13.

5554. "Improvements in apparatus for covering wire or conductors." R. WOOD. Dated April 14.

5586. "Improvements relating to holders or supports for electric incandescent lamps, and to contact devices for use therein, and for other purposes." H. H. LAKE. (Communicated by C. Grivolas, France.) Dated April 14. (*Complete.*)

5640. "Improved means to be used in supplying, distributing, controlling, and indicating electricity for lighting und other purposes." H. EDMUNDS. Dated April 16.

5681. "Improvements in switches used for electrical purposes." C. S. SNELL. Dated April 17.

5704. "Improvements in switch boards or apparatus for the distribution of electricity." J. S. RAWORTH. Dated April 17.

5708. "Improvements in dynamo-electric machines and motors." J. LEA and C. JULIAN. Dated April 17.

5723. "The production of chalybeate waters by electrolytic action, and apparatus therefor." W. WEBSTER. Dated April 17.

5731. "Improvements in, and relating to, apparatus for measuring electric currents, which apparatus will also serve as a motor." H. H. LAKE. (Communicated by Elihu Thomson, United States.) Dated April 17. (*Complete.*)

5732. "Improvements in, and relating to, apparatus for measuring electric currents, which apparatus will also serve as a

motor." H. H. LAKE. (Communicated by Elihu Thomson, United States,) Dated April 17. (*Complete.*)

5745. "An instrument for use in making electrical contacts." S. H. GILLAM. Dated April 18.

5753. "The Daisy long distance telephone and transmitter." G. HUCK. Dated April 18.

5782. "A new or improved electric arc lamp." W. C. MOUNTAIN. Dated April 18.

5783. "Improvements in electrical transformers." W. C. MOUNTAIN. Dated April 18.

5790. "Improvements in and relating to the preparation of non-metallic porous bodies for electro-metallurgic deposits." H. STEINACH. Dated April 18.

5811. "Improvements in, and connected with, the generation and distribution of electrical power, chiefly by alternating currents." R. E. B. CROMPTON and J. SWINBURNE. Dated April 19.

5831. "Improvements in means or apparatus for lifting, lowering, and regulating the height of the elements in electric batteries." T. SCHONHERR-SCHONER. Dated April 19.

5848. "An apparatus for performing operations at intervals, applicable to the making of electric contacts, or for analogous uses." H. EDMUNDS. Dated April 19.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1887.

1862. "Secondary batteries." C. D. ABEL. (Communicated from abroad by A. Dun, and F. Hasslacher, both of Frankfort on the Main.) Dated February 5. 6d. Claim:—In secondary batteries of the kind referred to the combination of an exciting liquid consisting of caustic alkali solution, in which is dissolved a metallic oxide, the metal of which only dissolves in the liquid when the circuit is closed, a positive electrode of a conducting material that is not effected by the caustic liquid, and a negative electrode consisting also of a conducting material that is not affected by the caustic liquid, surrounded by a layer of a metallic oxide that can assume a higher stage of oxidation, and is not dissolved in the exciting liquid.

1904. "Improvements in the construction of transformers." G. KAPP, W. H. SNELL, and J. M. V. KENT. Dated February 7. 8d. According to one arrangement the core is formed of a number of plates of a U or V-shape, and of suitable size, which may be economically stamped out of thin hoop or sheet iron so that when any number are placed face to face a trough is formed. The plates are insulated, and upon their upright sides or horizontal base the coils of insulated wire are placed. Two such troughs may advantageously be placed side by side, separated if desired by distance-pieces, to provide for efficient ventilation, thus forming a double trough, and the coils would then be placed over the adjacent sides of the troughs. These coils in which the primary and secondary currents circulate may be separately wound and placed side by side, so as to be readily detachable. A cover for the trough is also provided, formed of separate rectangular plates, adapted to fit upon the top of the trough, and these plates are insulated from each other, and may be wound or provided in the direction of the length of the trough with a coil which may be detachable as described. The claims are 5 in number.

1952. "An improved electric switch." A. F. DEWAR and F. WILSON. Dated February 8. 8d. Consists of a spindle, the outer end being provided with a handle, the said spindle carrying contact arms, the ends of which are turned at right angles. The lower end of the spindle is provided with inclined surfaces or cams adapted to fit into or work upon or against corresponding inclined surfaces or cams on a fixed boss. The inclined surfaces of the spindle are held against the inclined surfaces of the boss by means of a suitable spring or springs. When in the contact position—that is to say, in the position for closing the circuit—the ends of the contact arms press against suitable contact springs. If the spindle be now turned by means of its handle one quarter of a revolution, the inclined surfaces of the spindle sliding against the inclined surfaces of the boss will cause the spindle to be raised until the inclined surfaces reach their limit, when the spring will move the spindle down into the next or insulating position, the spring locking the parts in this position until they are again moved into the contact position by turning the spindle in the opposite direction to that hereinbefore described. The claims are 3 in number.

1993. "Apparatus for electrolysing bleaching solution." E. HERMITE, E. J. PATERSON, and C. F. COOPER. Dated February 8. 11d. Relates to the construction of the electrolysing apparatus in such a manner as to render it effective by exposing large and clean surface to the circulating liquid, and readily accessible for repair or for varying the degree of the electrolysing influence. For the positive electrodes the inventors use a number of thin sheets of platinum stiffened at their edges by non-conducting material, or they may be plates having their surfaces coated with platinum as foil or as deposit on them. Between the sheets of platinum we arrange the negative electrodes consisting of sheets of zinc. As the zinc is liable to receive on it deposit from the electrolysed liquid they provide for cleansing its surface in several ways. One way is to make the zinc in the form of discs fixed on shafts caused to revolve slowly, while knives or scrapers are pressed by weights or springs against the surfaces of the discs. According to another arrangement the zinc discs remain stationary, while scrapers are caused to revolve in contact with their surfaces. Instead of making the zinc surfaces in the form of discs, they may be in the form of cylinders slowly revolving while the scrapers bear against them, and in that case the platinum sheets are bent into circular form, so as to surround at a little distance the zinc cylinders. Or, again, the cylinders of zinc, instead of revolving, may be caused to reciprocate to and fro within tubes of platinum of larger diameter, while stationary scrapers bear against the zinc surfaces. In all cases they arrange the platinum and zinc surfaces near each other, but at sufficient distance to allow a flow of liquid between them, and they prefer to ensure the circulation by suitable pumps. When the zinc discs or cylinders are made to revolve or reciprocate as above described their connection with the electrical conductor is made by brushes or rubbers. In the electrolysing vessel and pipes communicating with it no metal other than zinc or platinum is employed; generally the vessel itself and the pipes are best made of ceramic or such like material. The claims are 5 in number.

2130. "Improvements in electrical inductors and commutators therefor." F. JEHL. Dated February 10. 8d. In constructing an inductor according to the invention, the inventor uses soft iron in wire or separate small plates or strips which he piles together so as to form two rings, taking care to make such disconnections in each ring as shall prevent circulation of electrical currents through them. He winds each ring transversely with coils of insulated wire, and he fixes the two coiled rings close to each other side by side, or the one within the other, and he connects two diametrically opposite ends of the one coil to the primary leads, and also two diametrically opposite ends of the other coil to the secondary leads, taking care to connect them in such a way that when the iron cores of the two rings are magnetised by an electrical current, the N pole of the one is in the closest possible proximity to the S pole of the other. The inductor itself may be fixed on the shaft with the commutators, so that all revolve together, the currents being led to and from the commutators by fixed brushes bearing against them. Or the inductor may be stationary while the commutators revolve, and in that case each commutator plate is connected to a ring against which bears a brush connected with one of the inductor coils or sections of coil. On causing the armature to revolve primary and secondary currents are produced, or on transmitting through the apparatus a primary continuous current the armature is caused to revolve, while at the same time the primary current is converted by the inductor into a secondary current. The claims are 6 in number.

2134. "Improvements in miners' safety lamps and in galvanic batteries especially suitable therefor." A. SCHANSCHIEFF. Dated February 10. 8d. Claims:—1. A single fluid battery, consisting of a cylindrical vessel of circular or other section, and a cover fitting tightly on to it, to which elements of about half the length of the vessel are attached, so that by inverting the vessel the battery can be put out of operation, substantially as described. 2. A battery lamp consisting of a cylindrical vessel of circular or other section, a cover fitting tightly on to it, to which elements of about half the length of the vessel are attached, and a glow lamp carried by the cylindrical vessel, the wires leading from the battery elements to the lamp being imbedded in the cover and sides, the whole arranged so that by inverting the vessel the battery can be put out of operation, substantially as described. 3. A miner's lamp or other lamp battery, substantially as described, and consisting of a vessel with radial partitions, a cover to which elements of about half the length of the cell are attached; a stem fixed in the vessel and passing through the centre of the cover; a screw nut or fastening upon the stem serving to secure the cover, and the whole so arranged that by inverting the vessel the battery can be put out of operation. 4. In battery lamps protecting the glow lamp by a glass, which is prevented from being removed while the battery is in operation, substantially as described. 5. Apparatus substantially as described and shown by the drawings.

3611. "Improvements in laying electrical conductors underground." G. FORBES. Dated March 9. 8d. The inventor inserts insulators of porcelain, glass or other material, in cast iron pipes; preferably two in each pipe. These insulators may be of disc form with the periphery resting in the cast iron pipes, or the periphery may have knobs or projections which rest on the pipes, thus giving a smaller surface of contact for leakage of electricity. The vacant spaces thus left between the projections at the periphery are also serviceable for allowing a current of dry air to circulate freely through the system; each of these discs has one, two, or more, holes in it through which the conductors pass. the number of these holes depending upon the number of conductors of different potential which are in use. Split tubes, which may be of tinned iron, copper, or other metal, each one a little longer than the cast iron pipes, are passed through corresponding holes in the insulators contained in each iron pipe. Where two of the outer pipes are joined together the ends of the split tubes in the interior of one pipe are connected to the ends of the split tubes in the other. Preferably to do this one of them is squeezed at its end to enable it to slip a few inches into the other one, when, on being released, it springs out and is held firm by the other split tube. The conductors themselves consist of naked wires without any insulation and are drawn through the tubular conduits, whose primary purpose is simply to support the wire conductors. These wires are pulled through the tubes from manhole to manhole, and their number is made to suit the requirements of the district, and

is increased as the consumption of electricity in the district increases. The corresponding ends in a manhole are soldered or otherwise joined together. The claims are 4 in number.

3782. "Improvements in electric telegraphs." E. EDWARDS. (Communicated from abroad by D. Kunhardt, of Germany.) Dated March 12. 8d. Relates to further improvements in telegraphic apparatus of the kind described in letters patent dated January 7th, 1887, and numbered 266. There is one claim.

3783. "Improvements in Morse keys with multiple contacts for simultaneously transmitting the same telegram to several stations." E. EDWARDS. (A communication from abroad by E. Cassalette and D. Kunhardt, of Germany.) Dated March 12. 8d. Claim:—A Morse key with multiple contacts for simultaneously transmitting the same telegram to several stations, the said key consisting of a pivoted lever bearing on its upper surface metallic blades forming part of or connected with transmitting contact points, and rest or silent contact points on the lower surface of the key, the current from the batteries being conducted to the said blades by means of elastic metal blades and by spring blades so as to effect a reliable and simultaneous contact for every line, the said key being also provided with a spiral spring to obtain the rest or silent contact, and a shunt or shunts being arranged to exclude the several lines, as may be required, all substantially as described and for the purpose set forth and shown.

3785. "Improvements in junction and testing boxes for electrical conductors." E. W. BECKINGSALE. Dated March 12. 6d. Claims:—1. In junction and testing boxes for electrical conductors the use of a liquid hydrocarbon, or heavy oil, or a mixture of such hydrocarbon and other substance or substances, for the conductor to dip into, the said hydrocarbon or mixture being of greater specific gravity than water, as and for the purposes specified. 2. The improved junction and testing boxes for electrical conductors fitted with insulating racks and filled with a liquid hydrocarbon or mixture of liquid hydrocarbon and other substance or substances, substantially as described.

3792. "An electrical fire alarum." H. S. PETIT and H. S. BRESSON. Dated March 12. 8d. A bar of metal of considerable transverse section has stretched on and in front of it a fine wire of the same metal. The middle of this wire is pressed against by a spring, and carries an electric contact piece which, in the ordinary condition of the apparatus, is either in contact or out of contact with conductors leading to an alarum at a distance. When changes of temperature take place gradually, both the bar and the wire expand or contract equally, and the electrical contacts remain unaltered. But when there is a rapid elevation of temperature near the apparatus, the wire expands more quickly than the bar, and the spring pressing on its middle gives it such flexure, that the contact piece which it carries is moved out of or into contact, thereby opening or closing the electric circuit of the alarum. The tension of the wire and the force of the spring, as well as the position of the contacts, are adjustable by screws so that the apparatus may be made more or less sensitive; also the bar may be more or less covered by non-conducting material for the same purpose. The claims are 2 in number.

3917. "Improvements in registering apparatus for use in connection with telephones." C. WITTENBERG. Dated March 15. 8d. Relates to an improvement in that class of telephone registers in which the act of registering the number of times that the telephone is used, is performed jointly by the person using the telephone at a subscriber's station and the operator at the exchange station. The object of the improvement is to provide means whereby the mechanism which actuates the register shall be set preparatory to carrying the register forward one point, by means of an electro-magnet controlled by the operator at the exchange, and shall then be operated to carry the register forward by the movement of the switch lever, by which the subscriber connects his telephone with the line, the arrangement being such that the switch-lever, which forms also a support for the telephone receiver, has a movement entirely independent of the registering mechanism, so that the exchange may be called any number of times without affecting the register until the actuating mechanism has been set by the operator at the exchange; the weight of the receiver when hung up then operating to carry the register forward one point. The claims are 4 in number.

9725. "Improvements in dynamo-electric machines." W. P. THOMPSON. (A communication from abroad by G. Westinghouse, of America.) Dated July 12. 8d. The object of the invention is to provide a simple form of machine for producing alternating electric currents. Certain features of the invention are applicable to other forms of generators than those delivering alternate currents. The invention involves many details of construction relating to the frame-work of the machine, the bed-plate upon which it rests, a devise for adjusting the position of the frame upon the bed-plate for the purpose of modifying the tension of the driving belt, the construction of the field-magnet and the pole-pieces, the mounting of the armature, and various other details. The claims are 10 in number.

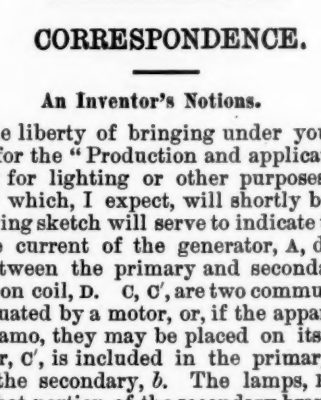
14260. "Means for preventing induction in telephonic circuits." S. C. DREW. Dated October 20. 6d. Consists in the employment of two coils, one as a primary induction coil, and the other as a secondary induction coil. One of these coils is put in circuit with the wire leading to the battery, so that the battery current will pass through it on its way to the transmitter. Close beside this first mentioned coil, or end to end with it, is placed a second coil, which is connected with the telephone. The vibrations passing over the wire leading from the transmitter will pass by induction to the second induction coil, while the induced currents which may have effected the conductor will competely cut off all intervening space between the two coils, and will not affect at all the coil which is connected with the telephone. The coils are to be adjusted with reference to their distance from each other, so as to have them as near together as possible, and yet sufficiently far apart to stop induced currents. Ordinarily they should be placed as near to each other as possible, without touching, so that the rims of the spools nearly touch when they are placed side by side; and when they are placed end to end, the ends of the spools and metal coils should nearly touch. The claims are 3 in number.

15588. "Improvements in dynamo-electric machines." J. Y. JOHNSON. Dated November 14. 6d. Claims:—1. In the construction of dynamo-electric machines the combination of a toothed armature with an electro-magnet or magnets having cores formed by plates or laminæ of sheet iron, each plate or laminæ being cut out in one or several pieces, the said plates or lamina being packed together side by side and insulated from one another in the same way as the plates forming the armature or induced part, substantially as described with reference to the drawings. 2. The combinations and arrangements of parts constituting improvements in dynamo-electric machines, substantially as described and illustrated in the drawings.

CORRESPONDENCE.

An Inventor's Notions.

I take the liberty of bringing under your notice my invention for the "Production and application of electric energy for lighting or other purposes," the specification of which, I expect, will shortly be published. The following sketch will serve to indicate the principle of it. The current of the generator, A, divides at *m* and *m'* between the primary and secondary wires of the induction coil, D. C, C', are two commutators which may be actuated by a motor, or, if the apparatus is used with a dynamo, they may be placed on its shaft. The commutator, C', is included in the primary branch, *b'*, and C in the secondary, *b*. The lamps, B, are shown placed in that portion of the secondary branch in which a direct current is flowing, but if it is desired to use an alternating current they may be inserted at *d* or *e*.



I think I cannot do better than describe some of the experiments which led to my applying for a patent. As, however, my measuring instruments were limited to incandescent lamps, these experiments were of the roughest description.

My first experiment was with a single commutator and one induction coil. This was wound throughout with No. 16 wire, two layers for primary and four layers for secondary, with a 1¼ inch core of iron wires. Having a small sized 4-cell Grove battery I procured a lamp suitable for such a battery. At first a better effect was produced by the coil than by the battery alone. After the battery had been in use for some time I found that the coil did not give such a good effect as the

battery did alone. From this it appeared that there was no advantage in having such a combination. I had the idea, however, that if I were to rectify the currents in the secondary circuit and lead them into the primary parallel with the battery current, possibly an increased effect might be obtained. It would not work, so I arranged the wires as shown in the sketch, with excellent results. With two coils in series the effect was increased.

The results of my next experiment were somewhat surprising, and rather puzzled me. I had six coils connected in series. They were of the same construction as the one described above. The current of five Bunsen's elements, pint size, passed through two 9-volt 5 C.P. lamps heated the filament to a dull white only. This was due to the nitric acid used being nearly spent. I then attached the lamps and the battery to the apparatus, as shown, and rotated the commutators at such a speed as would give 4,000 alternations per minute. The lamps now glowed at their full power. By substituting a 20-volt 10 C.P. lamp I obtained better effects. This lamp glowed so brightly that the filament appeared to be dangerously near breaking. Further, the current rose instantaneously to its full strength and did not fluctuate, although the speed of rotation was varied considerably. A compass brought near the ends of the coils was not disturbed in any way when the commutators were standing still. From this it was evident that self-induction was counter-balanced.

In the absence of other means of measuring the currents I have been unable satisfactorily to account for these apparently extraordinary results. It will, perhaps, be obvious, notwithstanding that if it is possible to obtain an increased current from the generator by reducing the external resistance, this method affords us the means of so doing, and, also, of varying the potential in almost any desired way.

I tried dividing an alternating current, but it was of no use. Why, I cannot exactly say.

I have made the invention applicable to alternate current dynamos also. According to one method, one set of the armature coils and the primary coils form a separate circuit, while another set and the secondaries form another circuit. The currents may be rectified or not. Take away the battery shown in the sketch and join m and m' and it will give you some idea of the connections when the currents are rectified.

These are the principal features of my invention, and if you can see your way to give a short description of it in your journal I shall be extremely grateful.

John Ross.

Dundee, *April 18th*, 1888.

[We cannot see that our correspondent has hit upon anything new, and his results can be readily understood by those conversant with transforming apparatus. It is evident that with the battery alone the E.M.F. was not high enough for the lamps employed, and that by using an induction coil he obtained, apparently from force of circumstances, and not from any previous knowledge of what might be expected, better results. If he supposes that he has discovered a method of obtaining a greater amount of electrical energy from his combination than can be produced from his initial source of energy he is labouring under a delusion.—EDS. ELEC. REV.]

Something Like an Invention!

I am at present engaged on an invention which, I believe, sirs, will create a revolution in all learned societies. You will pardon the proverbial enthusiasm of an inventor, but this thing is so very good that, though I am unable at the moment to acquaint you with its details—the patent being just applied for—I cannot refrain from giving you a general idea of the principle upon which it acts. I do this because the necessity for something of the kind is daily becoming more obvious, and the successful adoption of the appliance is certain to bring a shoal of imitators. When my rights are challenged I will triumphantly point to the columns of your journal and say: "Behold I am the first and original inventor of the 'Electro-mechanical Automatic Closure.'"

The apparatus consists essentially of a comfortable leather-covered chair connected mechanically and electrically with a conical extinguisher suspended by a cord above the seat. The cord is wound round a pulley, which being released at the proper moment by clockwork allows the extinguisher to descend.

I intend opening negotiations immediately for supplying these electro-mechanical automatic closures to the Council of the Society of Telegraph-Engineers, feeling certain that, owing to the garrulity displayed by several of the members, there will be ample opportunity at their meetings for testing their efficiency.

The appliances act thus:—When the members enter the room the extinguishers are in their normal position, that is, suspended at some distance above their respective chairs. When a member sits down an electrical contact works a relay, which frees the clockwork but does not start it. On the member rising to speak the breaking of a contact causes the clockwork to start, which runs on silently for ten minutes. At the end of that time the extinguisher pulley is released and the extinguisher descends, thus closing up the prosy F.R.S. or long-winded professor who may be at the moment inflicting his oratory on a long-suffering audience. If he has the sense to sit down before the ten minutes expire he is saved, for the act of sitting down immediately stops the clockwork upon which the fall of the extinguisher depends.

Now what do you think of this invention? Is not my immortality secured? Have I not invented an appliance for which present and future generations will bless my name?

M.S.T.E.

[Since our correspondent asks our opinion we may tell him that we consider his invention ingenious, though, perhaps, impracticable. We are not quite sure whether the communication is not a thinly veiled satire on the Council of the Society, the invention being a mere fiction introduced to give it point. At any rate it would be a great advantage to members generally if the prosy F.R.Ss. and long-winded professors referred to would take the hint.—EDS. ELEC. REV.]

Insulating Electric Light Conductors.

Having seen a note in your issue of the 13th inst. on the great differences in the insulating resistances given in lists of rubber insulated cables, I would like, with your permission, to say a few words that may, I hope, help towards a right solution of the problem.

And first, I must distinguish between two classes or types of cables—viz., those insulated with pure rubber tapes and those insulated with what I will call compound rubber, in contradistinction to pure. With regard to the first type, I do not remember to have seen in any maker's lists a definite insulation resistance given, probably on account of the great variations that may be obtained according to the conditions of the test, owing to the rubber not forming a continuous waterproof covering.

I have supposed, therefore, that your remarks were only intended to apply to cables insulated with compound rubber. In your note you suggested two explanations—viz., that the differences might arise from incipient faults or from differences in the quality of the insulating material, and to these I would add a third, which seems to have been rather overlooked—namely, a different ratio between the thickness of the insulating coating and its mean surface, and this, I think, goes a long way towards explaining most cases, as, so far as my experience goes, I have always found a difference, and generally a substantial difference, in the thickness of the insulating coating on cables of various classes, all having the same sized copper conductor. The first of your explanations I would dismiss as

very unlikely, as it would practically mean that less care was taken in the manufacture of all the cables of one class than of those of another; and with regard to the second, although agreeing with you that it is often the correct explanation, yet I do not think that it necessarily follows that the rubber is good, bad, or indifferent, according as the insulation resistance is high, low, or medium. My reason for this is that I take all compound rubbers to be mixtures treated in different ways so as to bring about changes in the mechanical strength and physical qualities of the material, as well as in the electrical ones; and I can quite believe that the addition of some particular substance might at one and the same time lower the specific resistance of the mixture, and yet increase its toughness and power to resist abrasion, cracking, or uncentreing of the copper when being handled, or the harmful action of acids and gases; and a cable insulated with such a material would, in my opinion, be as good as or even better for underground work than many another having a higher insulation resistance. What is the most suitable cable for underground work is much too big a question to enter on here, but should you be able at any future time to find space in your valuable journal for them, I would be pleased to send you a few notes which might, at any rate, serve to open up a discussion on the subject, if they did nothing more.

S. A. Russell.

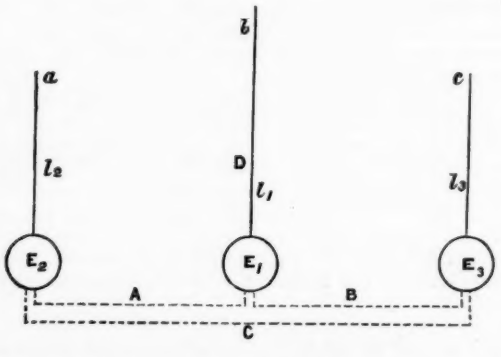
April 24th, 1888.

[We shall be pleased to hear again from Mr. Russell on a topic so important.—EDS. ELEC. REV.]

A Method of Testing Earth Resistances.

With reference to the article headed "A simple test for determining the resistance of an earth," which appeared in your issue of the 20th inst.

No doubt most of your readers will be familiar with the formula given in Messrs. Munro and Jamieson's pocket-book for ascertaining the earth resistance—in fact, so familiar has it become, that it will not be necessary to reproduce it. Some time ago it was found necessary to test a lightning conductor, and it seemed to me that some of the tests and calculations given in the book before mentioned were not in any way required. This will no doubt have occurred to many others, but since the appearance of the article referred to, I thought it might be as well if a place could be found for the amended formula in your Journal.



I intend to illustrate it by the same figure as that used by Munro—see rough sketch attached. In the formula given by Munro, it is necessary to know the resistance of the leads L 1 and L 2, of L 1 and L 3, and L 2 and L 3; but in the method I have tried with success, the resistance of L 1 only need be known, which I will call D, and the following test only taken, *i.e.*, the resistance between point *a* and *b*, which I will call A; that between *b* and *c*, which I will call B; and between *a* and *c*, which I will call C.

From the following formula the resistance of E 1, which is required, may be calculated.

$$E\,1 = \frac{A + B - C - 2D}{2}.$$

It is obvious that, as the resistance of L 2 and L 3 enter into A, B and C, just as much as E 2 and E 3, it is no more necessary for their resistance to be known than that of E 2 or E 3. This method will no doubt appear to most people to be quite as efficient, and to contain by far fewer calculations and tests. Another advantage is, the test may be taken by the Wheatstone bridge, the connections being made in the ordinary way, or by any other method of taking resistances.

Geo. Edwin Fletcher,
Stud. Inst. C.E., A.S.T.E. & E.

Fire Telegraphy and False Alarms.

I should be obliged if you would permit me to make a few remarks on the subject of the article in last week's REVIEW, entitled, "Fire Telegraphy and False Alarms."

The first fire alarms placed by the Exchange Telegraph Company in the streets of London repeated the signals—which were recorded at the fire station on a band of paper—several times. The combinations necessary to form the number of the signalling posts each consisted of three groups of dots, separated by spaces as $\overset{2}{\cdot\,\cdot}$ $\overset{5}{\cdot\,\cdot\,\cdot\,\cdot\,\cdot}$ $\overset{4}{\cdot\,\cdot\,\cdot\,\cdot}$, and they could not easily be formed several times over by accident.

Moreover, the most excellent possible safeguard against false alarms being sent maliciously was in the signal post itself. A loud trembling bell was placed inside, and so connected that immediately upon the door being opened or the glass broken it commenced to ring. This apparatus was placed in the posts at the suggestion of Captain Shaw, and was the means of detecting and causing the punishment of persons tampering with the fire alarm apparatus. But the provision, and also that of a record, was not considered necessary when other systems were introduced which did not contain either of them.

Upon such a system as that which I have described we received in one year 19,431 signals without a single failure having been reported, and although not used for fire signalling purposes, I cannot see any reason for more accidents to occur in one case than the other.

From the table it is evident that everything in the nature of an interruption has been put down as "fire alarms received from street posts." I do not think that our apparatus would record as an intelligible fire alarm signal an interruption caused by "collisions of vehicles with alarm posts;" and I am convinced that a system of the kind, if it had been generally adopted, with the posts much more numerous in the streets and with circuits containing a greater number of posts, would have been perfectly free from "faults due to defects in the electric alarm system."

The tendency at present is to place a single post upon a wire, thus increasing the cost enormously and decreasing the efficiency, for while two wires by this system would serve for at least 50 posts, 50 wires would be necessary for the single wire system.

The posts, when numerous, become convenient and accessible testing places and enable leakage faults to be removed before they cause an interruption to the service.

The only reason for the removal of these fire alarms of our earlier system was because the pillars were large, they having been purposely made nearly as large as a pillar letter box, to enable another apparatus, such as a sounder or telephone, to be worked to the fire station to convey orders, &c., from the scene of the fire.

The false alarms sent maliciously are dependent upon the temperament of the people and the enterprising spirit of youth, and would probably be unaffected by the description of apparatus employed if unprovided with the warning bell which I have mentioned.

F. Higgins.

April 24th, 1888.